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ANALYSIS OF RESIDENCE TIME DISTRIBUTIONS IN WATER TREATMENT PROCESSES AS RELATED TO THE CT CONCEPT

BY

LEONARDUS E. LIEM

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE**.

IN

ENVIRONMENTAL ENGINEERING

DEPARTMENT OF **CIVIL ENGINEERING**

EDMONTON, ALBERTA

FALL, 1994

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The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled **ANALYSIS OF RESIDENCE TIME DISTRIBUTIONS IN WATER TREATMENT PROCESSES AS RELATED TO THE CT CONCEPT** submitted by **LEONARDUS E. LIEM** in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **ENVIRONMENTAL ENGINEERING.**

Daniel W Smith

D. W. Smith - Supervisor

S. J. Stanley - Co Supervisor

J. J. Leonard - Committee Member

Date: July 27, 1994.

ABSTRACT

The assessment of the disinfection practice in water treatment has moved away from total reliance on the analysis of microbial contaminants in the finished water to the incorporation of disinfection kinetics concept to determine the adequacy of the disinfection process. The movement is highlighted by the promulgation of the Surface Water Treatment Rule (SWTR) in 1989 in the United States. Among other things, the SWTR requires the assessment of disinfection process based on the CT concept (disinfectant concentration multiplied by effective contact time). For the effective contact time, the t_{10} (time for 10% of the water to pass through the process) is stipulated by the SWTR. In most cases, the t_{10} must be determined through tracer tests.

The primary objective of this study is to determine the hydraulic characteristics of various treatment components of the E. L. Smith Water Treatment Plant in Edmonton, Alberta. Since the use of disinfection materials is associated with the SWTR / CT concept, the emphasis is given to the effective contact time (t_{10}) determination.

Ten tracer tests were conducted using NaCl solution (131,000 mg/L) in a step input at different flow rates (141 to 230 ML/d) and different sampling periods (3 to 52 hours). There were about 2,700 samples taken with the tracer recoveries of 84 to 107 %. Sodium ions in the samples were measured using a flame emission photometer.

The F curves were then generated, in which the t_{10}, t_{90}, Morril's index, and Baffle parameter values were directly obtained. Based on the baffle parameter, the filters are classed as "superior", clarifier no.2 is "poor", and the three reservoirs are "poor" and "unbaffled". Modification is necessary for reservoirs nos. 2 and 3 by constructing baffles or diffusers. Reservoir no. 1 and clarifier no. 2 may need some modification. The filters do not require modification.

The tracer concentration curves were analyzed using the common models found in the literature including the Wolf - Resnick, CMRs - in - series, and Rebhun - Argaman models that based on empirical approaches. For the reservoir without baffle, it was found that early portions of the tracer appeared earlier than predicted. Since the t_{10} is located in that part of the curve, its prediction using the models may not be reliable and will over predict the actual t_{10}. The cause of the extremely low t_{10} values for reservoirs nos. 2 and 3 were thought to be the result of the momentum from the inlet to the outlet. Subsequently, early portions of the residence time distributions were modelled as if they were caused by a jet.

The jet model was found to be adequate in predicting the t_{10} for this situation. The model seemed to indicate that the aberration was caused by the momentum dominant effect in the reservoir. This finding highlights the need to minimize the momentum from the inlet in order to obtain acceptable t_{10} values. Although these two reservoirs are relatively new and would be considered well designed according to traditional design guidelines, the lack of consideration of minimizing the momentum from the inlet has resulted in these two reservoirs to be classed as "poor" for effective contact time.

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ABBREVIATIONS

A	= area (m^2)
a	= degree of CMR (%)
α	= exponential coefficient, or regression parameter
α_1	= shear layer inner angle (°)
α_2	= shear layer outer angle (°)
α_e	= entrainment velocity coefficient
AFR	= arbitrary flow reactor
A_o	= nozzle area (m^2)
A_s	= surface control area (m^2)
$\underline{b}$	= r value when u = 0 (m)
b	= r value when u = 0.5 x u_m (m)
β	= time shift coefficient (min.), or b/$\underline{b}$, or regression parameter
b_y	= distance when $u_s = 0.5\ u_m$ (m)
b_z	= distance when $u = 0.5\ u_s$ (m)
C or c	= chemical concentration (mg/L)
C_1	= experimental parameter
C_f	= final concentration at steady state including background (mg/L)
c_m	= maximum chemical concentration (mg)
CMR	= complete mixed reactor
C_o	= initial chemical concentration (mg/L)
c_p	= peak chemical concentration (kg/m^3)
c_s	= chemical concentration at X-Z plane (mg/L)
CT	= disinfectant concentration times effective contact time (mg/L.min.)

C_t	= tracer concentration (mg/L)
d	= fraction of dead space (%), or day
DBP	= disinfection byproduct
d_o	= nozzle diameter (m)
D_x	= axial dispersion coefficient ($m/min.^2$)
d_x	= axial dispersion index
ε	= eddy diffusivity
F	= constant
f	= degree of short circuiting (%)
f, g, h	= function of
η	= r/b
HPC	= heterothropic plate count
H_2SiF_6	= hydrofluosilicic acid
i	= suffix
ICP	= inductively coupled plasma
k	= experimental coefficient
kg	= kilogram
L	= lag (min.), or liter
l	= length of travel (m)
M	= total tracer mass (kg)
m	= lag factor, or meter
mg	= milligram
min	= minute
ML	= megaliter
N	= number of CMRs in series, or number of microorganisms
ν	= fluid kinematic viscosity ($m^2/min.$)

n	= suffix, or coefficient of dilution
NaCl	= sodium chloride
nm	= nanometer
N_o	= number of initial microorganisms
NTU	= nephelometric turbidity unit
p	= degree of PFR (%)
PFR	= plug flow reactor
ppb	= part per billion
Q	= water flow (ML/d)
θ	= non dimensional time
Q_d	= desired flow (ML/d)
Q_t	= tracer study flow (ML/d)
q_t	= tracer flow (L/s)
qy, qz	= exponential parameters
r	= detention time correction factor, or radial distance from jet axis (m)
ρ	= fluid density (kg/m^3)
r_1	= inner shear layer radius (m)
r_2	= outer shear layer radius (m)
r_A	= chemical reaction rate (mg/L s)
R_e	= Reynold number
R_i	= Richardson number
r_o	= nozzle radius (m)
σ	= E curve standard deviation
σ_θ	= non dimensional E curve standard deviation
SWTR	= the Surface Water Treatment Rule
t	= time (min.)

τ	= turbulent shear stress (kg/m min.^{2})
$t_{10,50,90}$	= time when certain percentages of flow have passed (min.)
t_{10d}	= desired t_{10} (min.)
t_{10t}	= tracer study t_{10} (min.)
t_a	= actual residence time = time to reach curve centroid (min.)
t_b	= time or width of E curve at 10% C_o (min.)
t_c	= time or width of E curve at 50% C_o (min.)
TCU	= true color unit
T_d	= theoretical residence time (min.)
T_{dTot}	= total theoretical residence time for CMRs in series (min.)
THM	= trihalomethane ($CH\text{-}X_3$)
t_p	= time to reach peak concentration (min.)
t_z	= time when first tracer is monitored (min.)
u	= mean axial velocity (m/min.)
u_m	= maximum axial velocity (m/min.)
U_o	= initial axial velocity (m/min.)
u_s	= maximum axial velocity at X-Z plane (m/min.)
USEPA	= the United States Environmental Protection Agency
V	= volume (m^3)
v	= mean radial velocity, or mean vertical velocity (m/min.)
v_e	= entrainment velocity (m/min.)
v_{ey}	= vertical entrainment velocity (m/min.)
v_{ez}	= perpendicular entrainment velocity (m/min.)
ω	= experimental parameter
w	= mean perpendicular velocity (m/min.)
x	= axial distance along jet axis (m)

ψ = experimental parameter

y = vertical distance from jet axis (m)

z = perpendicular distance from jet axis (m)

1.0 INTRODUCTION

1.1 Background

Health risks due to microorganism contamination in drinking water have become critical issues in North America with the emergence of newly - recognized waterborne disease - causing organisms in the last two decades. It was not until 1976 that people started to pay attention to protozoan types of microorganisms (e.g., Giardia lamblia and Cryptosporidium parvum), bacterial type of microorganism (e.g., Legionella pneumophila), and enteric viruses as the causes of many outbreaks of waterborne diseases in the United States (Marroco, 1987, Reasoner, 1991, and Herwaldt et al, 1992). Even helminths were also suspected of causing outbreaks (Philpot, 1989).

The conventional disinfection practice that was able to handle common bacterial outbreaks in the past, such as typhoid and cholera by employing chlorine (in the form of chloride of lime, sodium hypochlorite, Cl_2, and chloramines) needs to be improved since these new types of microorganisms seem to be more formidable to inactivate (White, 1992).

Indicators of microbial quality, such as turbidity, coliform bacteria, and heterothropic plate count bacteria (HPC) that used to be the most common parameters to identify the possible presence of pathogenic organisms should be used cautiously as well. Several studies have proven that these indicators do not correlate well with the occurrence of these more newly recognized organisms (Le Chevallier and Norton, 1992).

Increasing or modifying the conventional disinfection practice is necessary to reduce health risks. Still, it is not only expensive but it also has a potential to produce other health risks such as carcinogenecity of disinfection byproducts (DBPs) (Sobsey et

al, 1993). During studies conducted in 1974, chloroform, one type of trihalomethane (THM), was identified in a chlorinated drinking water as a DBP produced from reactions between chlorine and organic materials (Bellar et al, 1974). By 1991, there have been more than 700 types of DBPs identified by the United States Environmental Protection Agency (USEPA) (Moser, 1991).

Reducing the health risk associated with waterborne disease outbreaks needs broader knowledge to be able to determine the method that yields the best risk reduction. Developing and applying an overall health risk assessment for microbial and also chemical contamination are necessary in order to define a health risk management plan (Sobsey, 1993).

In order to handle these problems, a strategy has been proposed using different types of disinfectant that have higher inactivation potency but do not produce THMs directly. Inactivation steps have been improved as well by applying multi - barrier processes in the treatment plant. The first, known as primary disinfection, aims at the total inactivation of pathogenic organisms in the system. For many reasons, chlorine dioxide and ozone are gaining popularity as primary disinfectants. Secondly, baseline treatments, such as filtration and sedimentation, have been integrated into the disinfectant protocols (Bryant et al, 1992). Direct filtration, slow sand filtration, and diatomaceous earth filtration are considered as very good barriers for many kinds of organisms (Guidance Manual, 1989). A case study reported by Glicker and Edwards (1991) shows that unfiltered systems did have serious problems with Giardia . Bank filtration wells constructed near a river were proposed by Hilterbrand et al (1991) as another similar concept of filtration. The last step is secondary disinfection. It protects system from newly introduced or regrowth of pathogenic organisms. Chloramines, due to their stabilities in water, have become a very common type of secondary disinfectant in North America.

The Surface Water Treatment Rule (SWTR) introduced by the USEPA in 1989 sets new treatment requirements to protect all public water supplies using surface water sources and ground water sources under direct influence of surface water. For some microbial contaminations, the SWTR proposes treatment methods as a condition for compliance rather than establishing maximum contaminant levels (MCLs). The SWTR introduces the concentration multiplied by time (CT) concept as a new treatment method to reduce the health risk due to microorganism contaminations in drinking water. The emphasis is given to the inactivation of Giardia lamblia and enteric viruses. Basically, the concept considers disinfectant concentration C and hydraulic effective contact time T as an inseparable unit to ensure the inactivation process. Determining the contact time using tracer studies is the most common method to follow. A tracer chemical can be injected into a system in a continuous or instantaneous input. Statistical curves, the E and F curves, can be developed to represent the residence time distribution of the chemical in the system. The CT concept also gives some credits to physical processes, filtration and sedimentation, that remove unwanted particles and organisms in the water.

It is evident that disinfection is no longer as simple as "chlorination - coliform" any more. It deals not only with the quality of drinking water leaving the plant, but also with the quality of the treatment and distribution systems plus a complex knowledge of health risk concerns. As a consequence, physical processes, fluid mechanics, public health education, risk assessment, and many other areas are gaining significant roles besides other conventional disciplines, such as microbiology and chemistry. This thesis presents a study which assesses the disinfection contact time parameter as applied to the SWTR / CT concept in a large water treatment plant.

1.2 Scope of Study

The primary objective of this study was to the determination of the hydraulic

characteristics of various treatment processes of the E. L. Smith Water Treatment Plant in Edmonton, Alberta. The main emphasis is given to determine the t_{10} values of various systems. However, the study does not include overall calculation of the actual CT values of the treatment plant since a preliminary study was already completed by the Process Development Team in 1989 - 1990 (Process Development Team, 1991). The data obtained from this study give additional information to the previous study. It is also important to develop relations between flow rates and residence time distributions to predict the hydraulic characteristics at different flow rates rather than those tested. Confidence in this relationship is required as the City of Edmonton is planning to expand the treatment plant to a greater flow capacity.

In order to meet the objective of the study, tracer tests were conducted for one clarifier, a set of filters and clearwell, and three on - site reservoirs. Most of the tests were completed at two different flow rates. The results were analyzed using traditional residence time distributions, the E and F curves. A number of common models suggested by Marske and Boyle (1973), the Guidance Manual (1989), Thirumurthi (1969), Levenspiel and Bischoff (1963), Wolf and Resnick (1963), and Rebhun and Argaman (1965) were discussed in this study, including the direct interpretation of time values, baffle parameters, dispersion models, degree of PFR and dead space model, and CMRs - in - series model. However, most of those models are based on empirical and statistical approaches. In many cases, they do not fit well with the real data obtained from a particular test. It was therefore necessary to develop a more physically - based model that not only fits the obtained data better, but also gave more confidence in its application at different flow rates.

In the case of three reservoirs tested, it was found that the common models listed above failed to provide satisfactory results. A further investigation found that initial portions of the residence time distribution curves were mostly governed by the initial

momentum - dominated jet at the inlet point. The jet model was found to be the appropriate model to use to fit the real data.

Based on tracer tests and analyses of the results, it is possible to present a discussion about residence time distributions of various systems in the treatment plant. The discussion includes an overview of the analysis method using the common models and jet model, and also several comments to the SWTR / CT concept.

2.0 LITERATURE REVIEW

2.1 SWTR and CT Concept

With the promulgation of the new regulation, disinfection practice has reached its new and modern stage. For some microbial contaminants, the SWTR gives an emphasis to the treatment methods as a condition for compliance rather than establishing maximum contaminant levels (MCLs). The CT concept is proposed as the new treatment assessment technique to reduce health risks due to microorganism contamination.

The main idea of the CT concept is based on the Watson model that includes C (disinfectant concentration), T (hydraulic effective contact time), and n (parameter or coefficient of dilution). The relationship among those parameters can be described as follows (Canadian Water and Wastewater Association, 1993):

$$C^nT = \text{constant} \qquad (2.1).$$

Plotting C and T for inactivation of a certain type of microorganism in a particular time T on a log - log scale will give a straight line with a slope equal to n. Inactivation level of 99% is chosen in most cases. For the CT model, it is assumed that n equals to unity. It means that both C and T have the same importance in determining the CT product. Note: C is the important factor for $n>1$, while T becomes the significant factor for $n<1$.

Correlation between the survival of microorganisms N/N_0 and the contact time T can be expressed using the Chick model (Canadian Water and Wastewater Association, 1993):

$$\log \frac{N}{N_o} = -kT \qquad (2.2)$$

where k is a constant. Ideally, a plot of log N/N_o vs. T should yield a straight line, expressing the first order kinetics condition. However, deviations often occur in real situations such as shoulder, initial rapid, and tailing curves (Hoff, 1987).

The Guidance Manual (1989) employs the CT concept to achieve at least 3 log (99.9%) and 4 log (99.99%) inactivation levels of Giardia cysts and viruses, respectively (Guidance Manual, 1989). Higher inactivation levels may be necessary considering the cyst concentration, see Table 2.1 (AWWARF, 1993). The numbers are based on the annual risk of 10^{-4} per person. The infected dose for Giardia can be as low as 1 cyst only. It is assumed that a person drinks 2 L of water a day. In the case of 1 cyst / 100 L for example, it is logical to apply 3 log reduction level in order to have a risk less than 10^{-4}. In the case of viruses, it is assumed that viruses occur at higher concentration in source waters, have more health risks, and are more infectious than Giardia. Therefore, it was decided to have higher inactivation levels than those for Giardia (Guidance Manual, 1989). The Guidance Manual (1989) also assumes that using those two microorganisms as the parameters will also provide protection to heterothropic plate count (HPC) bacteria and Legionella.

The Guidance Manual (1989) assumes that degree of microorganism inactivation is proportional to the product of C (disinfectant concentration used, in mg/L) and T (hydraulic effective contact time, in minutes). As will be discussed later, t_{10} or time for 10% of the flow passes through the process, is assumed to be the hydraulic effective contact time. Standard CT values have been specified for different types of disinfectant: free chlorine, chloramines, chlorine dioxide, ozone, and ultraviolet light, for different pH values (6 to 9), and for different temperatures (0.5° to 25° C). For example,

Table 2.1: Inactivation Levels (adapted from AWWARF, 1993)

Giardia	Geometric Mean of Allowable Daily Average Cyst Concentration (Cysts/100L)		
	<1	1 to 10	10 to 100
Giardia cyst removal - inactivation	3 log	4 log	5 log
Virus removal - inactivation	4 log	5 log	6 log

standard CT values for inactivation of viruses using chlorine dioxide can be seen in Table 2.2. Other standard CT values for different conditions can be found in the Guidance Manual (1989). Filtration gives some credits for the CT values in the range of 1 log (90%) to 2.5 log (99.3%) reductions, depending on the types of filtration used and microorganisms involved. In the case of coagulation / flocculation and filtration, a credit of 2.5 log reduction is given for Giardia cysts and a similar credit of 2.0 log reduction for viruses, with the remaining reduction obtained by the disinfection process (Bryant et al, 1992).

To meet the Guidance Manual (1989) criteria, CT values for a water treatment plant should be investigated. It is assumed that the plant satisfies the requirement if the value meets or exceeds the standard value. Still, standard CT values in the table were generated in perfect laboratory processes without the presence of other chemical compounds. Disinfectant dissipation, especially in the case of chlorine as it reacts with other chemical compounds in real water, should be taken into account (Teefy and Singer, 1990). The change in pH, temperature, and even sunlight penetration for open systems should be considered as well (Auckly and Borgerding, 1991). Another weakness of the CT concept is that one tends to extrapolate the standard value for a particular condition since the experimental data are relatively limited. The extrapolation is valid only if the relation between the surviving microorganisms and contact time in the Chick model (Equation 2.2) is ideal (a straight line for log N/N_o vs. T). Another difficulty arises in the assumption that n in the Watson model (Equation 2.1) is equal to 1. For disinfectant such as ozone, studies have shown that n may be as high as 3 (Zhou and Smith, 1994). It has generally been reported for chlorine that n is close to 1. Still, even for chlorine the value of n is not always unity (Hoff, 1987).

However, in a general case, the SWTR / CT concept is still an improvement over the use of MCLs as it considers the kinetics aspect of the process leading to

Table 2.2 CT Values for Inactivation of Viruses by Chlorine Dioxide for pH 6 to 9 (adapted from the Guidance Manual, 1989)

Removal	Temperature (°C)					
	≤ 1	5	10	15	20	25
2 log	8.4	5.6	4.2	2.8	2.1	1.4
3 log	25.6	17.1	12.8	8.6	6.4	4.3
4 log	50.1	33.4	25.1	16.7	12.5	8.4

disinfection. As has been mentioned by Regli (1989), the CT concept allows water processors to evaluate accurately their disinfection processes and to optimize the chemical usage in achieving the desired level of performance. The Guidelines for Canadian Drinking Water Quality (1993) is considered to be somewhat behind the SWTR / CT concept as it still uses the maximum acceptable concentration (MAC) to analyze the microbiological parameters without having specific criteria for enteric viruses and protozoa. Therefore, it is a very reasonable idea to apply the CT concept as a general measure of disinfection performance for water treatment plants in Canada although the USEPA itself does not have any legal status in Canada. In recognition of this, a preliminary investigation was completed as early as 1989 - 1990 by the City of Edmonton at the E. L. Smith and Rossdale Water Treatment Plants in Edmonton, Alberta (Process Development Team, 1991).

2.2 Residence Time Distributions

In very general terms, the residence time can be defined as the time needed for fluid particles to pass through in a process. A specific time parameter, in this case the hydraulic effective contact time, can be found by determining the residence time distribution. The use of the E and F curves obtained from tracer studies is the most preferable method to use. A tracer consisting of a non - reactive and non - toxic chemical compound can be added to a system in several ways including random input, cyclic input, slug / pulse input, and step / continuous input. On the whole, slug and step inputs are the most suitable as relatively simple mathematical or statistical modeling can be derived from the results.

2.2.1 Reactor Types

It is assumed that plug flow reactors (PFRs) and complete mixed reactors

(CMRs) are the ideal reactors that describe the two limits of residence time distributions found in actual reactors. In a PFR, the fluid travels smoothly as a "piston flow" from the inlet to the outlet with complete mixing in the axial direction without any longitudinal dispersion. The particles remain in the system for a time equal to the theoretical residence time (T_d):

$$T_d = \frac{V}{Q} \tag{2.3}$$

where:

V = system volume (m^3)

Q = incoming flow (m^3/min.).

Flow through a long system with a high length to width ratio like a pipe and flow through granular media filters are generally assumed to have a close resemblance to this type of flow. In the case of CMRs, complete mixing is expected to occur immediately when the fluid enters the system. The particles disperse throughout the system and leave in proportion to their statistical distribution. It can be achieved only if there is perfect mixing.

Even though the two types of ideal flow reactors have found great use in defining the outer bounds of reactors, arbitrary flow reactors (AFRs) are the most common reactor types found in real situations. They represent some deviations from PFRs and CMRs in that they do not follow either the ideal flow condition. To account for this, the CT concept suggests the use of t_{10} for the contact time, i.e. time when 10% of the flow passes through the system, instead of using the theoretical residence time (T_d) (Guidance Manual, 1989). By using this, it is assumed that at least 90% of fluid in the system has been exposed to the disinfectant for a period greater than t_{10}. Still, as

the standard CT values were generated from batch reactor experiments, more studies about the fluid behavior in different types of reactors must be conducted. Lev and Regli (1992) generated data based on dispersion and CMRs - in - series models. The result showed that the t_{10} was reliable only for high t_{10}/T_d values or in the case of low microorganism inactivation levels (up to 2 log reduction, but not for 4 log reduction).

2.2.2 E and F Curves Development

The E and F curves have long been used to assess the residence time distribution in real reactors. In the case of a slug input, a discrete amount of tracer is fed into the system at an instance, normally for a period less than 1/50 times T_d (Thirumurthi, 1969). The slug test residence time distribution function is given by the E curve. It can be explained in that the fraction of material at the outlet point that has been in the system for a time between t and t + dt is equal to E dt. The E(t) vs. t curve can be developed both for discrete and continuous variables as the function of C_i or C(t) (tracer concentration at a particular time in mg/L) and t (time in minutes) (Levenspiel and Bischoff, 1963):

$$E_i \equiv \frac{C_i}{\Sigma C_i \Delta t} \quad \text{,or}$$

$$E(t) = \frac{C(t)}{\int_0^{+\infty} C(t)\, dt} \qquad (2.4).$$

The area under the E curve represents the complete tracer recovery and should be equal to 1:

$$\Sigma E_i \Delta t_i \cong 1 \qquad \text{,or}$$

$$\int_0^{+\infty} E(t)\, dt = 1 \qquad (2.5).$$

Since the E curve still has dimensions (1/[time] for the vertical axis and [time] for the horizontal axis), it is also possible to use a dimensionless curve, i.e. the $E(\theta)$ vs. θ curve. It can be developed using relations among the previous parameters to define the t_a (actual residence time):

$$t_a \cong \frac{\Sigma\, t_i C_i \Delta t_i}{\Sigma\, C_i \Delta t_i} \qquad \text{,or}$$

$$= \frac{\int_0^{+\infty} t\, C(t)\, dt}{\int_0^{+\infty} C(t)\, dt} \qquad (2.6)$$

$$\theta = \frac{t}{t_a} \qquad (2.7)$$

$$\theta\, E(\theta) = t\, E(t) \qquad \text{,then}$$

$$E(\theta) = t_a\, E(t) \qquad (2.8).$$

For a step input, the tracer is added to the system continuously in a uniform concentration for a period of 2 to 3 times T_d or until it reaches the steady state condition (Hudson, 1975). The F(t) vs. t curve, represents the fraction of material at the outlet

point that has been in the system for a time less than t. For discrete and continuous variables, the equations are:

$$F_i = \frac{C_i}{C_o} \quad \text{,or}$$

$$F(t) = \frac{C(t)}{C_o} \quad (2.9)$$

where C_o is the initial tracer concentration of the step input in mg/L. To represent a complete tracer recovery, the value of F_i or F(t) should equal to 1 at the steady state condition. The non - dimensional curve $F(\theta)$ vs. θ, can be generated easily from the F curve as it is already dimensionless in the vertical axis. The horizontal axis can be developed by dividing t with t_a. The relation between the two vertical axes is:

$$F(\theta) = F(t) \quad (2.10).$$

After either the E or F curve has been identified, the other curve can be formed using the following equations:

$$E(t) = \frac{dF(t)}{dt} \quad \text{, or}$$

$$F(t) = \int_0^t E(t)\, dt \quad (2.11)$$

$$E(\theta) = \frac{dF(\theta)}{d\theta} \quad \text{,or}$$

$$F(\theta) = \int_0^{\theta} E(\theta)\, d\theta \qquad (2.12).$$

General equations for PFRs and CMRs have well been developed. In the case of PFRs, the E and F curves are identified as follow (Metcalf and Eddy, 1991):

$$F(t) = \frac{C(t)}{C_o} = 1 \qquad ,t \geq Td \qquad (2.13)$$

$$E(t) = \frac{C(t)}{C_o} = +\infty \qquad ,t = Td \qquad (2.14)$$

with the total area for Equation 2.14 equals to 1. For the CMR, it is necessary to develop the mass balance equation. It is expressed as follows (Metcalf and Eddy, 1991):

$$[\text{Accumulation}] = [\text{Inflow}] - [\text{Outflow}] + [\text{Generation}]\text{, or}$$

$$\frac{dC}{dt} V = Q C_o - Q C(t) + r_A V \qquad (2.15)$$

where r_A is the rate of chemical reaction (mg/L.min.). Assuming that the tracer compound is conservative ($r_A = 0$), a new equation for the step input can be derived by integrating Equation 2.15 from C = 0 to C:

$$F(t) = \frac{C(t)}{C_o} = 1 - \exp\left(-\frac{t}{T_d}\right) \qquad (2.16).$$

In the case of a slug input, the value of $Q.C_o$ in Equation 2.15 is equal to 0, as no tracer

is continuously added after the first addition. The integral is taken from $C = C_o$ to C:

$$E(t) = \frac{C(t)}{C_o} = \exp\left(-\frac{t}{T_d}\right) \qquad (2.17).$$

General equations for the AFR should be identified using tracer studies. Characteristics of the PFR, CMR, and AFR in the form of the E and F curves can be seen in Figure 2.1. Interpretation of the E and F curves is done by assessing the four characteristics listed below:

dead space:	no fluid motion in some parts of the system and there is perfect mixing in other regions,
short circuiting:	nearly instantaneously moving of the flow from the input to the output,
dispersion:	mass transport due to the velocity gradient, usually only axial or longitudinal direction to be considered. It characterizes the degree of back mixing during the flow,
errors factors:	some correction factors due to imperfectness of the system or assumptions made.

2.2.3 Single Stage with Closed - Closed System

The single stage system is formed by only one system. It is characterized by a straight line of the F curve when a log scale is used for the horizontal axis (Wolf and Resnick, 1963). Closed - closed system means that before and after the fluid enters the system, it acts as a PFR. Since the case study is related to reservoir systems with two pipes in the inlets and outlets, only the closed - closed system is going to be discussed.

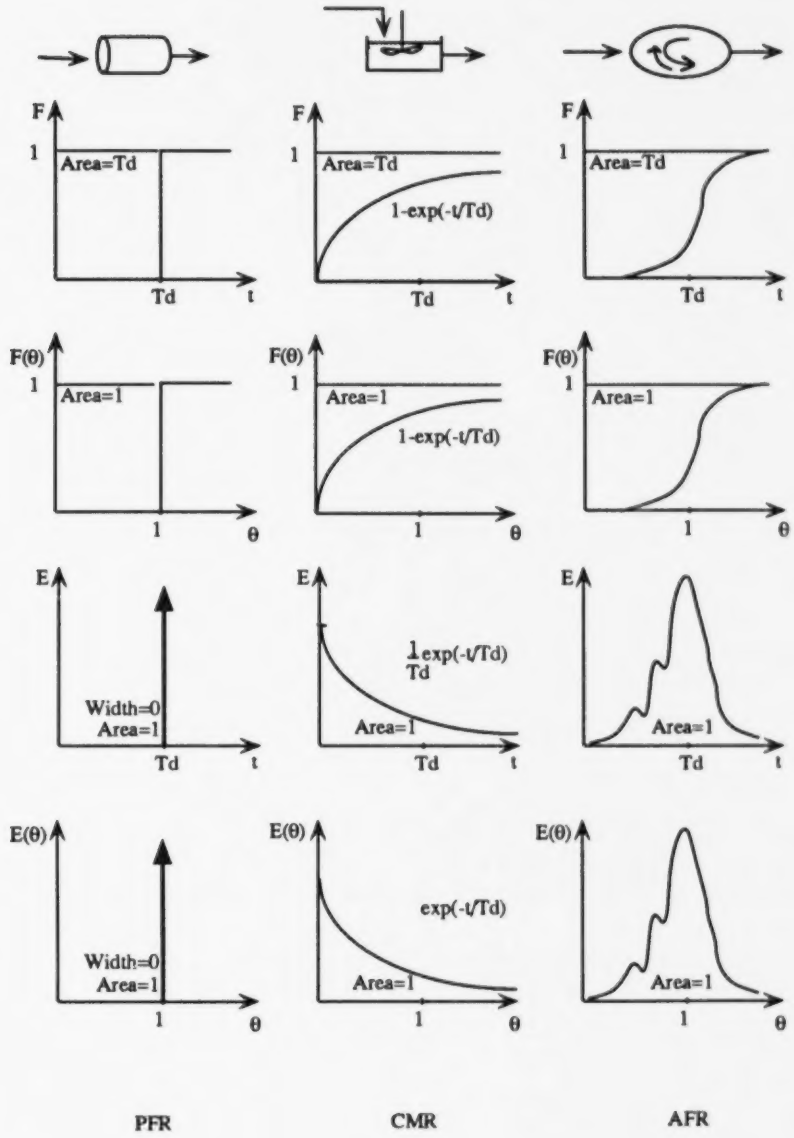


Figure 2.1: E and F Curves (adapted from Levenspiel, 1963)

2.2.3.1 E(t) vs. t Curve Interpretation

Models developed from this curve are quite simple. The idea is based on comparisons of the time parameters obtained from the curve (see Figure 2.2). These are the most common dimensionless parameters to use (Marske and Boyle, 1973):

index of mean residence time = $\frac{t_a}{T_d}$

index of average residence time = $\frac{t_{50}}{T_d}$

index of short circuiting = $\frac{t_Z}{T_d}$

Morril's dispersion index = $\frac{t_{90}}{t_{10}}$

index of modal residence time = $\frac{t_p}{T_d}$

where:

t_{10} = time for 10% of tracer to pass the system (min.)

t_{50} = time for 50% of tracer to pass the system (min.)

t_{90} = time for 90% of tracer to pass the system (min.)

t_a = time to reach the curve centroid (min.)

t_p = time to reach the peak concentration or modal value (min.)

t_Z = time when the first tracer is monitored in the effluent (min.).

In the case of PFRs, all of those parameters should equal to 1. While Brumo (1972) mentions three more dimensionless parameters, although traditionally they have not frequently been used:

index of eddy diffusivity caused by turbulence $= \frac{t_c}{T_d}$

index of turbulence and recirculation eddies $= \frac{t_b}{T_d}$

index of curve eccentricity $= \frac{(t_c - t_p) - (t_p - t_z)}{T_d}$

where:

t_c = time or width of the curve at 50% of C_o (min.)

t_b = time or width of the curve at 10% of C_o (min.).

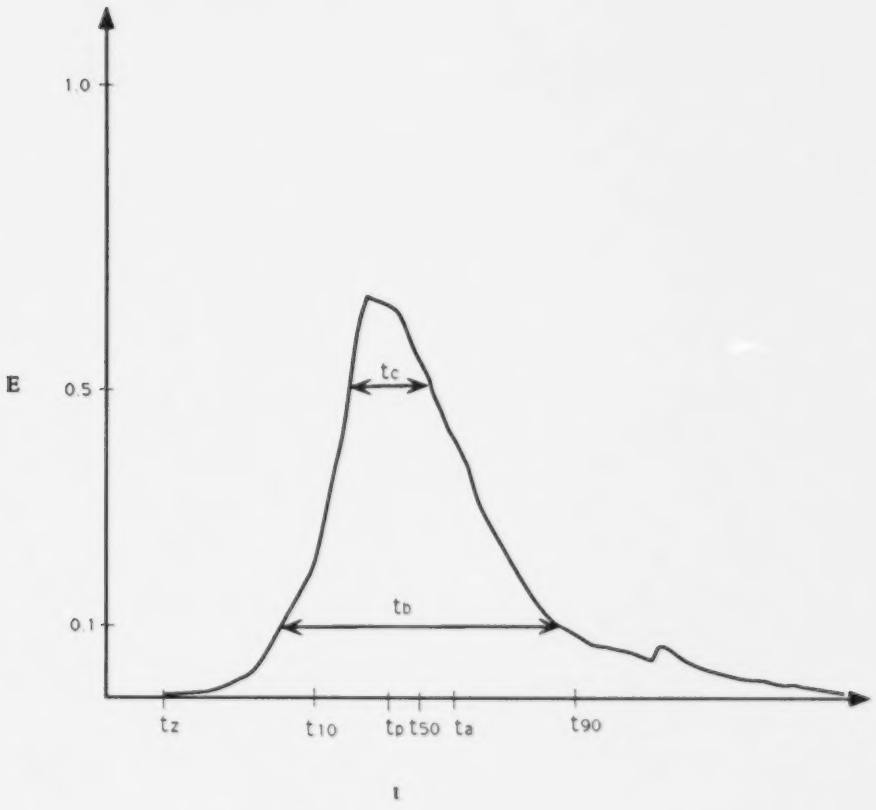


Figure 2.2: Time Parameters in the E Curve (adapted from Levenspiel and Bischoff 1963)

The first and second parameters should equal the tracer addition time in the case of PFRs, and should be 0.7 and 2.3 respectively for CMRs. The last parameter should be 0 for PFRs and 2.3 for CMRs (determined experimentally). However, the Morril's index is assumed as the best approximation to assess the axial dispersion (Gregory and Zabel, 1990).

Another approach is given by Scheible as cited by Thampi (1989). The idea is to consider the tracer concentration as a function of the axial dispersion coefficient (D_x):

$$c_p = \frac{M}{A\sqrt{4\pi D_x t_p}} \exp\left[\frac{-(l-ut_p)^2}{4D_x t_p}\right] \qquad (2.18)$$

where:

c_p = peak tracer concentration (kg/m^3)

M = total mass of tracer (kg)

l = length of travel (m)

A = cross sectional area of the flow (m^2)

u = axial velocity (m/min.)

t_p = time to reach the peak concentration (min.)

D_x = axial dispersion coefficient (m^2/min.).

Unfortunately, this approach is valid only for long cylinder systems. A more general formula that is applicable for any type of reactor can be found as a function of the standard deviation of the non - dimensional E curve (see the next section).

The Guidance Manual (1989) suggests the use of the baffle parameter (t_{10}/Td) to investigate the system performance. Several criteria have been identified, see Table 2.3 Basically, comparisons among the time parameters do give some qualitative

Table 2.3: Baffle Parameters (adapted from the Guidance Manual, 1989).

t_{10}/T_d	BAFFLE PARAMETERS	DESCRIPTIONS
<0.1	mixed flow / unbaffled	agitated basin, very low length to width ratio, high flow velocity
0.3	poor	single or multiple unbaffled inlets and outlets, no intra - basin baffles
0.5	average	baffled inlet or outlet with some intra basin baffles
0.7	superior	perforated inlet baffle, serpentine outlet weir or perforated launders
1.0	perfect (plug flow)	very high length to width ratio (pipe line flow), perforated inlet, outlet, and intra - basin baffles

assessments, but not quantitative determinations, as numerical relations among them are not known.

2.2.3.2 E(θ) vs. θ Curve Interpretation

A better method has been developed by considering the dispersion in the system that can be applied in all conditions. Usually only the axial dispersion is taken into account. The axial dispersion index (d_x) should be 0 in the case of PFRs and $+\infty$ for CMRs. It can be measured as a function of the standard deviation of the non - dimensional curve E(θ) vs. θ. It is considered to be a better model as it considers the entire curve, rather than only several discrete values like in the previous model. Several relations can be generated using these equations (Levenspiel and Bischoff 1963):

$$d_x = \frac{D_x}{u\ l} \tag{2.19}$$

$$\sigma^2 = \left(\frac{\Sigma t_i^2 C_i}{\Sigma C_i}\right) - t_a^2 \tag{2.20}$$

$$\sigma_\theta^2 = \frac{\sigma^2}{t_a^2} \tag{2.21}$$

$$\sigma_\theta^2 = 2d_x - 2d_x^2\,[1 - \exp(-d_x)] \tag{2.22}$$

$$E(\theta) = \frac{1}{(\pi\theta d_x)^{0.5}}\ \exp\left[-\frac{(1-\theta)^2}{4\theta d_x}\right] \tag{2.23}$$

where:

u = axial velocity (m/min.)

l = length of travel (m)

D_x = axial dispersion coefficient (m^2/min.)

d_x = axial dispersion index (no unit)

σ = standard deviation

σ_θ = standard deviation for non - dimensional condition.

Correlation between the E curve and the population of microorganisms over the time is presented by Trussell and Chao (1977) as follows:

$$\frac{N}{N_o} = \frac{1}{T_d}\left[\int_0^{\psi/T_d} E(\theta)\, d\theta + \int_{\psi/T_d}^{+\infty} \left(\frac{\psi}{C_o\, t}\right)^{\omega} E(\theta)\, d\theta\right] \qquad (2.24)$$

where:

N = number of microorganisms at time t

N_o = number of initial microorganisms

ψ = experimental parameter, for example: ψ equals to 2.8 for fecal coliform, etc.

ω = experimental parameter, equals to 3 for the original value, less than 3 as suggested by Hart and Vogiatzis (1982).

2.2.3.3 F(θ) vs. θ Curve Interpretation

Since the actual residence time (t_a) cannot be generated directly from the F curve, it is preferable to use the theoretical residence time (T_d). All of the error factors and other parameters are included in the following models (Wolf and Resnick, 1963):

$$F(\theta) = 1-\exp\{-\frac{(1-f)}{ar(1-d)T_d}[t-L-\frac{p(1-d)rT_d}{(1-f)} + mar(1-d)T_d]\}$$

$$,F(\theta) \geq 0 \qquad (2.25).$$

It is obvious that Equation 2.25 is quite complicated. Parameters p and a represent the fraction of the system that acts as a PFR and a CMR respectively, in which p + a = 1. Intercept of the curve with vertical axis represents the degree of short circuiting effect (f). Dead space fraction is measured by parameter d, while error factor for residence time can be measured using parameter r. Lag (L) and lag factor (m) represent the lag in response of the system. The model can be simplified in a different form by combining the parameters as can be seen in Equation 2.26:

$$F(\theta) = 1-\exp[-\alpha\frac{(t-\beta)}{T_d}] \qquad ,F(\theta) \geq 0 \qquad (2.26).$$

Parameter β represents the system phase shift or the intercept of the curve with horizontal axis, while α is the coefficient of exponent or the skewness of the entire curve. Rebhun and Argaman (1965) made a simplification by regarding only parameters p and d. Basically, this linearizes the Wolf and Resnick model:

$$F(\theta) = 1-\exp\{-\frac{1}{(1-p)(1-d)}[\frac{t}{T_d} - p(1-d)]\}, \text{ or}$$

$$\ln[1-F(\theta)] = -\frac{1}{(1-p)(1-d)}\frac{t}{T_d} + \frac{p}{(1-p)} \qquad (2.27).$$

As has been mentioned above, linearization of the original equation should result in a straight line for a single system. Using slope $\frac{1}{(1-p)(1-d)}$ and intercept of the line

with vertical axis $\frac{p}{(1-p)}$ obtained from the graph, p and d can be determined easily. The Guidance Manual (1989) also suggests the use of this method to assess the t_{10}. Yu et al (1991) conducted a study using basically the same method but a different sign (positive / negative) convention. Note: linearization using a log scale in place of ln scale can be used as well, adding the parameter log e to the equation.

2.2.4 Multi Stage with Closed - Closed System

This system is formed by N numbers of CMRs of the same volume in series. Unlike the single stage system, the F curve will produce a curve in place of a straight line if a log scale is used for the horizontal axis (Wolf and Resnick, 1963). The curves for a multi stage system can be seen in Figure 2.3. The equations for the E and F curves have been developed as written below (Levenspiel and Bischoff, 1963):

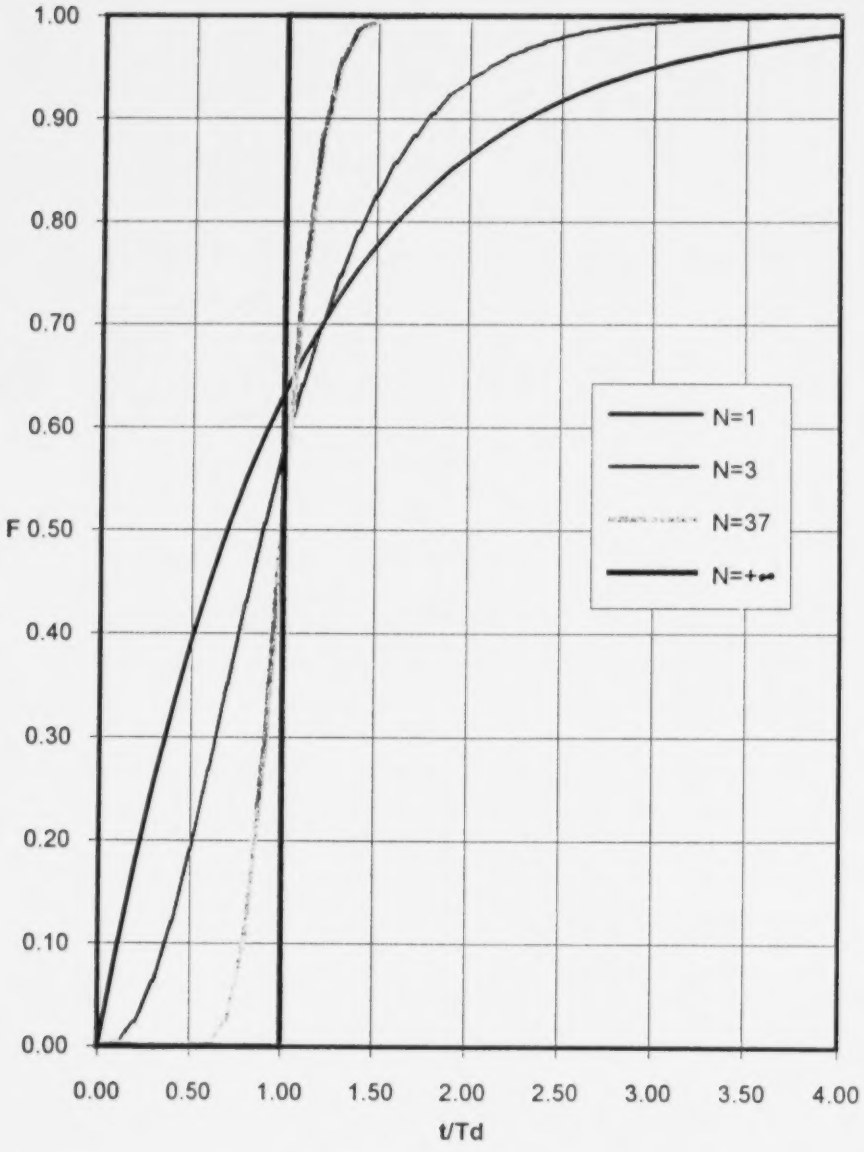
$$E(\theta) = (\frac{t}{Td})^{(N-1)} x \frac{1}{(N-1)!} \exp(\frac{-t}{T_d}) \quad (2.28)$$

$$F(\theta) = 1 - \exp(\frac{-Nt}{T_{dTot}}) x [1 + \sum_{i=N-1}^{i=1} (\frac{Nt}{T_{dTot}})^{i} \frac{1}{i!}] \quad (2.29)$$

$$T_{dTot} = N T_d \quad (2.30)$$

$$N = \frac{t_a^2}{\sigma^2} \quad (2.31)$$

where T_{dTot} is the total theoretical residence time of the whole systems, while t_a and σ can be obtained from the E curve. It is possible to find out parameter N (the number of tanks in series) for a multi stage system that fits to the tracer study data (Teefy and Singer, 1990). Yet, there is not any general formula can be applied as everything depends on the system characteristics. Another different idea is given by Hazen as cited


1.00
0.90
0.80
0.70
0.60
F 0.50
0.40
0.30
0.20
0.10
0.00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
t/Td
N=1
N=3
N=37
N=+∞

by Gregory and Zabel (1990):

$$N = \frac{t_{50} - t_p}{t_p} \qquad (2.32)$$

where t_p is time to reach the peak concentration.

2.3 Jet Model

Jet theory has commonly been used for years. However, it is employed basically in the area of pure fluid mechanics. The main objective of this study is to introduce the jet model as an applicable tool to predict the hydraulic effective contact time parameter (t_{10}) associated with the SWTR / CT concept. Since the modeling is correlated to reservoir systems with inlet and outlet pipes, only circular types of jets are going to be discussed in this study.

2.3.1 Basic Assumptions

First of all, it is necessary to draw a distinction between jets and plumes. A jet is defined as a source of momentum and energy produced from a discharge of fluid into a large mass of the same or similar fluid. While, a plume is formed by the difference in potential energy or the density difference between the discharged and the surrounding fluid, that creates buoyancy relative to its surroundings. There are five general assumptions made to analyze the jet theory (Rajaratnam, 1976 and Blevins, 1986):

1) homogeneous and Newtonian fluid (shear stress is a linear function of velocity gradient), although it is possible that the fluid carries chemical compounds,
2) non - compressible fluid, or Mach number $\left(= \frac{\text{flow velocity}}{\text{speed of sound}}\right) \leq 1$,
3) "slender flow" condition, or thickness of the jet is assumed to be small compared

to the distance of the section from the nozzle,

4) infinite system, fresh water always entrains into the jet, and

5) uniform static pressure, except for the jet action itself.

Due to the limited scope of this study, it is reasonable to apply six more assumptions to simplify the problem:

6) only circular submerged and surface jets are considered,

7) turbulent flow, or Reynold number ($R_e = \frac{\text{inertia force}}{\text{viscous force}}$) $\geq$ 3000 (Blevins, 1986),

8) no significant density difference between the jet and surrounding fluid, i.e., no buoyancy and plume effects,

9) total flux propagation has the same value no matter the shape of the jet,

10) the jet occurs relatively far from surfaces, walls, or other objects, and

11) constant flow through circular nozzle.

A jet with a nozzle diameter of d_o, or radius of r_o, will produce a flow development region. Basically, the jet development is characterized by the width of turbulent mixing and the decay rates of center line properties. When a jet is moving downstream, it mixes the surrounding fluid forming a shear layer. Turbulence created in the shear layer penetrates outwards and inwards into the jet, reducing continuously the thickness of the "potential core". The core will vanish after the jet has moved at about 9 r_o (see the next explanation). This region is called the flow development region. Usually, it is assumed that the axial velocity (u) and chemical concentration (c) at any point in the flow development region are equal to the initial axial velocity (U_o) and initial chemical concentration (C_o), respectively. Generally, most analyses are conducted in the fully developed region, the region downstream where the potential core has vanished (see Figure 2.4).

There should be three conservation conditions that exist in the fully developed region. The conservation of mass deals with u, U_o, initial nozzle area (A_o), entrainment

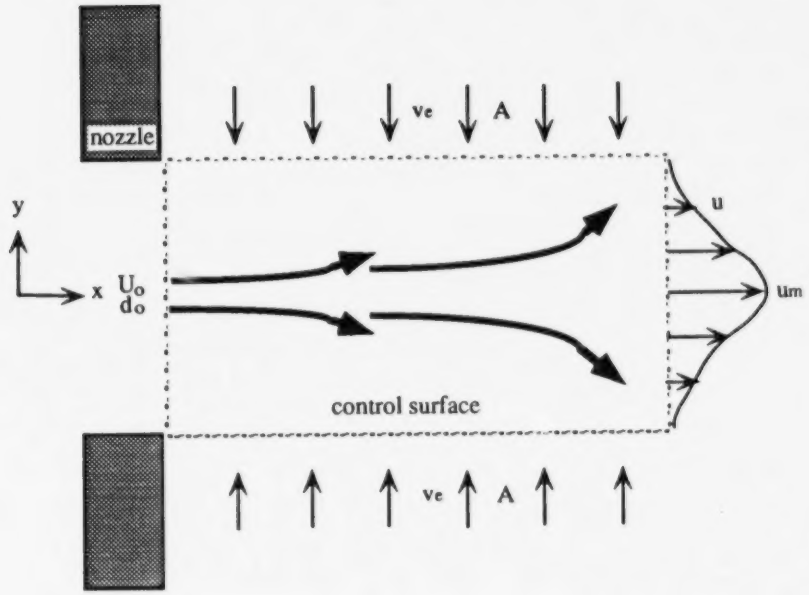


Figure 2.4: Jet Control Area (adapted from Blevins, 1984)

velocity (v_e), and area of the control surface (A_s):

$$U_oA_o + v_eA_s = \int_A u\, dA \qquad (2.33).$$

Chemical concentration C and C_o, are included in the species conservation:

$$C_oU_oA_o = \int_A cu\, dA \qquad (2.34).$$

It is obvious that entrainment must exist in order to achieve the validity between those two equations. Conservation of momentum in the jet is the last condition that must be fulfilled:

$$U_o^2A_o = \int_A u^2\, dA \qquad (2.35).$$

As the jet moves along its path, it brings or entrains the surrounding water into the jet. The flow increases due to the transfer of the momentum outwards the jet, while the velocity and the concentration decrease as there is more dilution in the jet. More specific forms of the equations are presented in the following sections.

2.3.2 Circular Submerged Turbulent Jet

The flow development region of a circular submerged turbulent jet can be described using a coordinate system of r (radial distance from center line) and x (axial distance from nozzle). Theoretically, a jet always starts to propagate from a certain location behind the nozzle. Yet, for convenience, it can be assumed to occur right at the nozzle itself (Rajaratnam 1983 and 1986). See Figure 2.5 for a complete description.

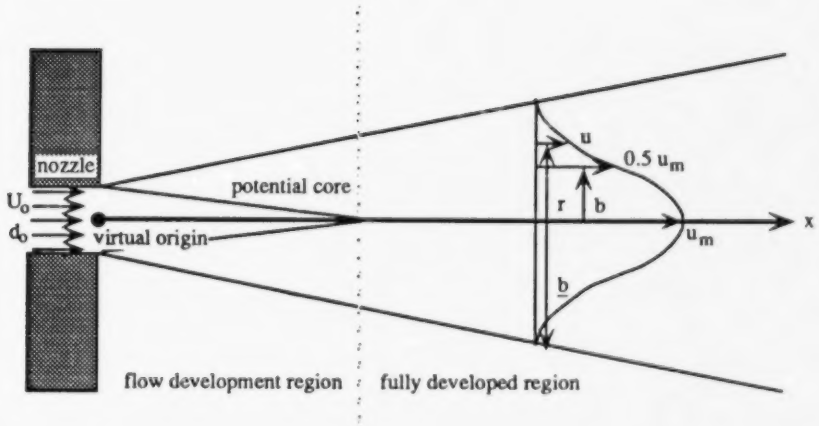


Figure 2.5: Circular Submerged Turbulent Jet (adapted from Rajaratnam, 1983)

The velocity distribution profile in the fully developed region can be determined as follows. The maximum axial velocity (u_m), which occurs at the center line, decreases continuously with the increase of x. Axial velocity (u) at any point at a radial distance r from the center line can be generated using these following equations. It is acceptable to simplify the relevant Reynold equations using axisymmetry and the slender flow condition (Rajaratnam, 1976):

$$u\frac{\delta u}{\delta x} + v\frac{\delta u}{\delta r} = \frac{1}{\rho r}\frac{\delta r\tau}{\delta r} \quad \text{,and} \qquad (2.36)$$

$$\frac{\delta ru}{\delta x} + \frac{\delta rv}{\delta r} = 0 \qquad (2.37)$$

where τ is the total shear at any point in the axial direction, and v is the radial velocity. In the case of turbulent jets, τ will be the same as the turbulent shear. Equation 2.37 represents continuity of the system.

Conservation of the axial momentum flux from Equation 2.35 can be developed in a more specific form by multiplying Equation 2.36 with ρr and then integrating it with respect to r from r = 0 to $+\infty$:

$$\frac{d}{dx}\int_0^{+\infty} 2\pi\rho ru^2\, dr = 0 \qquad (2.38)$$

where ρ is the fluid density. Initial axial momentum flux at the nozzle (M_o) is given by:

$$M_o = \int_0^{+\infty} 2\pi\rho ru^2\, dr = \frac{\pi d_o^2}{4}\rho U_o^2 \qquad (2.39).$$

Using the entrainment hypothesis, it is obvious that the flow (Q) always increases along the jet path as it entrains the surrounding fluid. This can be expressed as (Rajaratnam 1983 and 1986):

$$Q = \int_0^{\underline{b}} 2\pi\rho r u \, dr \tag{2.40}$$

$$v_e = \alpha_e u_m \quad \text{,and} \tag{2.41}$$

$$\frac{d}{dx} \int_0^{\underline{b}} ur \, dr = \alpha_e \underline{b} \, u_m \tag{2.42}$$

where v_e is the entrainment velocity, $\underline{b}$ is the the value of r when $u \cong 0$, and α_e is the entrainment coefficient. Equation 2.42 is basically the continuity equation in view of the entrainment hypothesis.

According to the reference, u/u_m is correlated well with $\eta = r/b$, where b is the value of r when $u = 0.5\, u_m$. The axial velocity distribution profile has been proven experimentally to follow a Gaussian normal distribution curve. Several assumptions should be made:

$$\frac{u}{u_m} = f_1(\eta) = \exp\left[-0.693 \left(\frac{r}{b}\right)^2\right] \tag{2.43}$$

$$u_m = k_1 x^p \tag{2.44}$$

$$b = k_2 x^q \tag{2.45}$$

$$\frac{d}{dx}(F_1 k_1 k_2^2 x) = \beta \alpha_e k_1 k_2 \qquad (2.46)$$

$$k_1 k_2 = \sqrt{\frac{M_o}{2\pi\rho F_1}} \qquad (2.47)$$

where $\beta = b/b$, parameters k_1 and k_2 are the x independent coefficients, p and q are the unknown exponents, and F_1 is an integral constant. Equation 2.46 is a development of Equation 2.42 considering those velocity parameters. Equation 2.47 correlates the initial momentum with those velocity parameters. Using the integral momentum and continuity equation, it is possible to calculate the exponents, $q = 1$ and $p = -1$. It is obvious that $u_m = f(1/x)$ and $b = f(x)$, see Rajaratnam (1983 and 1986).

The chemical concentration distribution profile in the fully developed region also has a Gaussian normal distribution type of curve. The maximum chemical concentration (c_m), which occurs in the center line, decreases continuously with the increase of x. Chemical conservation equations can be developed as follow (Rajaratnam,1976):

$$u\frac{\delta c}{\delta x} + v\frac{\delta c}{\delta r} = \frac{1}{r}\frac{\delta}{\delta r}(r\,\varepsilon_r\frac{\delta c}{\delta r}) \qquad (2.48)$$

$$\frac{d}{dx}\int_0^{+\infty} ucr\,dr = 0 \qquad (2.49)$$

where c is the chemical concentration at any point, and ε_r is the eddy diffusivity for chemical transport. Chemical flux at the nozzle (P_o) can be developed using a similar approach as that used in developing the initial momentum:

$$P_o = \int_0^{+\infty} 2\pi r dr \; u\, c = \frac{\pi d^2}{4} U_o C_o \qquad (2.50).$$

Experimental observations show that c/c_m is correlated well with $\eta = r/b$ even though it has different coefficients than that of u/u_m:

$$\frac{c}{c_m} = f_2(\eta) = \exp[-0.693 (\frac{r}{kb})^2] \qquad (2.51)$$

$$c_m = k_3 x^s \qquad (2.52)$$

$$k_3 = \frac{P_o}{2\pi} \frac{1}{F_2 k_1 k_2^2} \qquad (2.53)$$

where k, k_3, s, F_2 are constants. Equation 2.53 correlates the initial chemical flux with those chemical concentration parameters. Using the same method to solve the exponential parameters, it can be shown that s = -1, so that $c_m = f(1/x)$, see Rajaratnam (1983 and 1986).

The unknown parameters β, k, k_1, k_2, F_1, and F_2 need to be determined. Rajaratnam (1983 and 1986) suggest values of k = 1.17, k_2 = 0.097, β = 2.5, and α_e = 0.028 which yield constant F_1 = 0.361, F_2 = 0.417, and $k_1 = dU_o/0.164$. The new equations are:

$$\frac{u}{u_m} = \exp[-74 (\frac{r}{x})^2] \qquad (2.54)$$

$$\frac{u_m}{U_o} = \frac{6.1\, d_o}{x} \qquad (2.55)$$

$$\frac{c}{c_m} = \exp[-54 (\frac{r}{x})^2] \quad (2.56)$$

$$\frac{c_m}{C_o} = \frac{5.3\ d_o}{x} \quad (2.57).$$

Slightly different results are suggested by Chen and Rodi (1980), $k_2 = 0.086$ (confirmed by Blevins, 1984 and Ramaprian and Chandrasekhara, 1985). Those equations change slightly in the exponential constants, -94 for the velocity profile and -57 for the chemical concentration profile (Equations 2.54 and 2.56). Parameters for maximum values are slightly different as well, 6.0 for the maximum velocity and 5.0 for the maximum chemical concentration (Equations 2.55 and 2.57). Many equations can be derived based on the empirical parameters, still the velocity and chemical concentration profiles will not change as they are obtained from mathematical solutions.

Angles that form the shear layer of a jet development region can be seen in Figure 2.6. Rajaratnam (1976) derived several equations to describe the boundary of the shear layer as follow:

$$\frac{u}{U_o} = f_3(\eta) = f_3(\frac{r-r_1}{b}) \quad (2.58)$$

where r_1 is the inner radius of the shear layer. Combining those equations with Equation 2.36 gives:

$$(\frac{r_1}{r_o})^2 + (2F_3\frac{b}{r_o})\frac{r_1}{r_o} + [2F_4(\frac{b}{r_o})^2 - 1] = 0 \quad (2.59)$$

where F_3 and F_4 are constants which approximately equal 0.31 and 0.07, respectively.

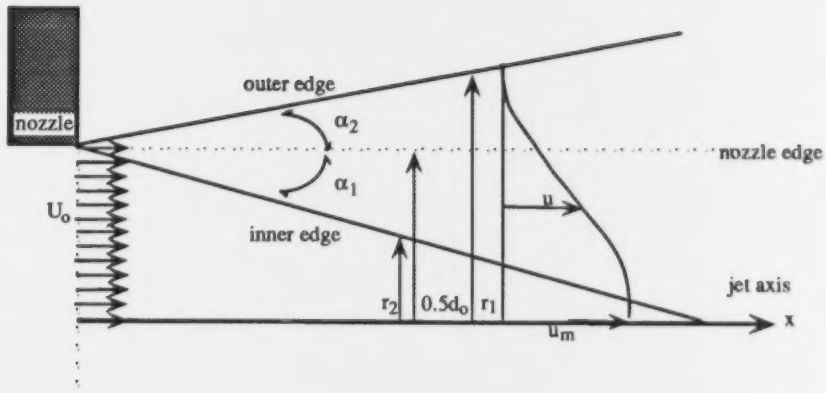


Figure 2.6: Shear Layer (adapted from Rajaratnam, 1976)

Using experimental observations (Rajaratnam, 1976), several new equations can be generated as written below:

$$\frac{r_1}{r_o} = 0.95 - 0.097\,\frac{x}{r_o} \tag{2.60}$$

$$\frac{b}{r_o} = 0.10 + 0.111\,\frac{x}{r_o} \tag{2.61}$$

$$\frac{r_2}{r_o} = 1.07 + 0.158\,\frac{x}{r_o} \tag{2.62}$$

where r_2 is the outer radius of the shear layer. Length of the potential core is about $9\,r_o$ (see Equation 2.62). According to the experiments, α_1 (inner angle of the shear layer) is about 5.7°, while α_2 (the outer angle) is about 9° (Rajaratnam, 1976).

Another approach is given by Mih (1983):

$$\eta = \frac{r}{k_4 x} \tag{2.63}$$

$$\frac{u}{u_m} = \exp(-\eta^2) \tag{2.64}$$

$$\frac{1}{r}\frac{d}{dr}(r\,v) + \frac{du}{dx} = 0 \tag{2.65}$$

$$\frac{v}{u_m} = \frac{k_4}{\eta}\{\exp(-\eta^2)\,[0.5+\eta^2]-0.5\} \tag{2.66}$$

where Equation 2.64 is another approach to the Gaussian curve. Equation 2.65 is basically the continuity equation by taking account of the mean radial velocity (v). Assuming that $v \equiv 0$ at the edge of the outer layer and k_4 (an experimental parameter) =

0.103, it is found that $\frac{r}{x} = 0.115$, or $\alpha_1 = 6.6°$.

2.3.4 Circular Surface Turbulent Jet

A circular surface jet occurs when the nozzle is located at the surface of the fluid, therefore the jet propagates along the fluid surface. It is important to figure out the behavior of this type of jet as the field testing in this study was related to reservoirs with inlet pipes at the water surface. The flow development region can be developed using a three ordinate system, x (axial distance from the nozzle), y (vertical distance from the center line), and z (transverse horizontal distance from the center line), see Figure 2.7. The continuity and Reynold equations are similar to those presented earlier (Rajaratnam 1988):

$$\frac{\delta u}{\delta x} + \frac{\delta v}{\delta y} + \frac{\delta w}{\delta z} = 0 \qquad (2.67)$$

$$u\frac{\delta u}{\delta x} + v\frac{\delta u}{\delta y} + w\frac{\delta u}{\delta z} = -\left(\frac{\delta}{\delta y}\overline{u'v'} + \frac{\delta}{\delta z}\overline{u'w'}\right) \qquad (2.68)$$

where u, v, and w are the velocities at the axial (x), vertical (y), and perpendicular (z) directions. Under the overbar signs are the time dependent variables of the velocity. By integrating Equation 2.68 from y and z = 0 to $+\infty$, two new equations can be generated:

$$\frac{d}{dx}\int_0^{+\infty}\int_0^{+\infty} ru^2 dydz = 0 \qquad \text{,and} \qquad (2.69)$$

$$\int_0^{+\infty}\int_0^{+\infty} ru^2 dydz = M_o = \frac{\pi}{4}\frac{U_o^2 x}{d} \qquad (2.70)$$

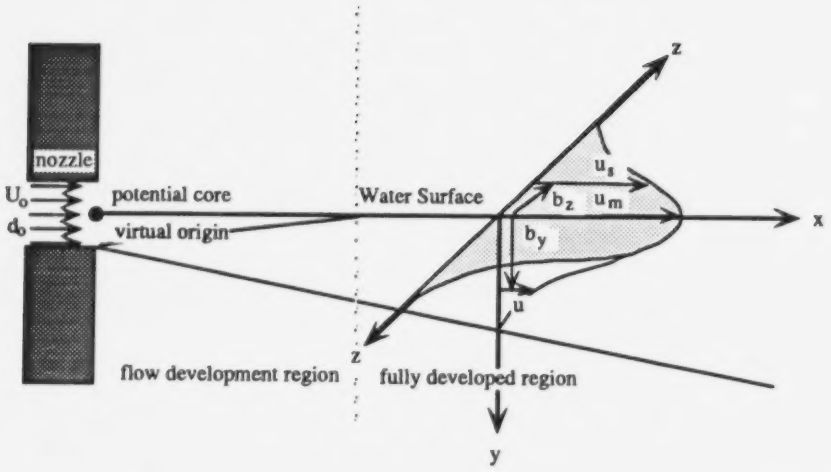


Figure 2.7: Circular Surface Turbulent Jet

where M_o is the initial momentum flux at the nozzle. As shown by Rajaratnam and Pani (1974), analyses for velocity profiles give:

$$\frac{u}{u_s} = f_4\left(\frac{y}{b_y}\right) \tag{2.71}$$

$$\frac{u_s}{u_m} = f_5\left(\frac{z}{b_z}\right) \tag{2.72}$$

$$u = u_m f_4 f_5 \tag{2.73}$$

$$u_m = k_5 x^p \tag{2.74}$$

$$b_y = k_6 x^{qy} \tag{2.75}$$

$$b_z = k_7 x^{qz} \tag{2.76}$$

where u_s is the surface velocity at X-Z plane, while b_y and b_z are the values of y and z when $u = 0.5\ u_s$ and when $u_z = 0.5\ u_m$, respectively. Parameters p, qy, and qz are exponents, while k_5, k_6, and k_7 are the experimental parameters. The entrainment concept is described as:

$$v_{ey} = -\alpha_{ey} u_m f_4(\eta_y) \tag{2.77}$$

$$v_{ez} = -\alpha_{ez} u_m f_5(\eta_z) \tag{2.78}$$

$$\frac{d}{dx}\int_0^{+\infty}\int_0^{+\infty} u\,dy\,dz = \int_0^{+\infty} -v_{ey}\,dy + \int_0^{+\infty} -v_{ez}\,dz \qquad (2.79)$$

where v_{ey}, v_{ez}, α_{ey}, and α_{ez} are the entrainment and coefficient velocities for the y and z directions, respectively. Using the same method for a circular submerged turbulent jet, the exponential parameters can be found to be $q_y = q_z = 1$, and $p = -1$. Rajaratnam (1985) mentions that in the case of circular surface turbulent jets, velocity profiles in the X-Y plane and in the X-Z plane follow Gaussian normal curves similar to the circular submerged turbulent jet:

$$\frac{u}{u_s} = f_4(\eta_y) = \exp\left[-0.693\left(\frac{y}{b_y}\right)^2\right] \qquad (2.80)$$

$$\frac{u_s}{u_m} = f_5(\eta_z) = \exp\left[-0.693\left(\frac{z}{b_z}\right)^2\right] \qquad (2.81).$$

Rajaratnam and Humphries (1984) found for the circular surface turbulent jet, that $b_y = 0.044x$ and $b_z = 0.09x$. So that the new equations are:

$$\frac{u}{u_s} = \exp\left[-358\left(\frac{y}{x}\right)^2\right] \qquad (2.82)$$

$$\frac{u_s}{u_m} = \exp\left[-86\left(\frac{z}{x}\right)^2\right] \qquad (2.83)$$

where u_s is the axial velocity in the X-Z plane. Rajaratnam (1985 and 1988) show the correlation between u_m and U_o as follows:

$$\frac{u_m}{U_o} = \frac{9\,d_o}{x} \qquad (2.84).$$

It was also showed that u_s sometimes occurred at some distance under the surface. Yet, it is acceptable to assume that u_s occurs exactly at the surface, so that the Gaussian curve types (Equations 2.80 and 2.81) are still valid (Rajaratnam and Humphries, 1984 and Rajaratnam, 1985).

Basically, similar equations can be developed for the chemical concentration distribution:

$$u\frac{\delta c}{\delta x} + v\frac{\delta c}{\delta y} + w\frac{\delta c}{\delta z} = \frac{1}{y}\frac{\delta}{\delta y}(y\,\varepsilon_y\frac{\delta c}{\delta y}) + \frac{1}{z}\frac{\delta}{\delta z}(z\,\varepsilon_z\frac{\delta c}{\delta z}) \qquad (2.85)$$

$$\frac{d}{dx}\int_0^{+\infty}\int_0^{+\infty} cu\,dy\,dz = 0 \qquad (2.86)$$

$$\int_0^{+\infty}\int_0^{+\infty} cu\,dy\,dz = P_o = \frac{\pi d^2}{4}U_o C_o \qquad (2.87).$$

Rajaratnam (1985) also shows that concentration profiles both for X-Y and X-Z planes follow the Gaussian normal distribution curves as have been mentioned above (Equations 2.78 and 2.79), but the values for b_y and b_z are different. Several experiments have been conducted considering the Richardson number (R_i) ($=\frac{\text{consumption of energy by buoyant convection}}{\text{consumption of energy by turbulent shear flow}}$). However, as the density difference is neglected, the Richardson number becomes very small or $\cong 0$. Rajaratnam (1985) mentions that $b_y = 0.044$, while $b_z = 0.57\ R_i^{1/8}$ for $R_i = 0.00003$ to 0.0031. For the smallest value (0.00003), b_z equals 0.16. So that, the new equations are:

$$\frac{c}{c_s} = \exp\left[-358(\frac{y}{x})^2\right] \qquad (2.88)$$

$$\frac{c_s}{c_m} = \exp\left[-27\left(\frac{z}{x}\right)^2\right] \qquad (2.89)$$

where c_s is the chemical concentration at X-Z plane. While the maximum concentration that occurs at the surface can be found using Jen et al data (1966):

$$\frac{c_m}{C_o} = \frac{7\, d_o}{x} \qquad (2.90).$$

During the same experiment, the shear layer for z (X-Z plane) and y (X-Y plane) directions were obtained by them as well: about 13° and 20°, respectively. Tamai et al (1969) confirm those data.

2.3.5 Application to CT Concept

The use of jet hydraulics to analyze tracer test results is balanced by the desire to incorporate a more physically based model which fits the observed results better than existing empirical models. As will be discussed later, it was not until the tests were completed that it was found that for the two reservoirs, the tracer appeared at the outlet almost immediately after its addition. This indicated that momentum from the jet at the inlet might cause this phenomena. However, unlike most hydraulic studies of jets, no velocity nor concentration profiles in the jet were taken due to the closed nature of the reservoirs. As a result, the obtained data are somewhat a "black box" in nature with only the inlet and outlet measurements. The primary goal of this analysis was to determine if the inlet jet could be responsible for the very fast transport of the tracer through the reservoir. If this was found to be the case, results could be used to determine the t_{10} values at other flow rates and plant modifications to improve the residence time

distribution. The complexity of the jet analysis was therefore tempered by the lack of measurements to define the jet. Therefore, the overall purpose of this study is to determine the residence time distribution using the jet model, not to do the detailed jet hydraulic analysis.

Theoretically, the circular surface turbulent jet is the most appropriate model to use. Unfortunately, there are several difficulties in analyzing the total flux using this model. Parameters b_y and b_z for the axial velocity are obtained for X-Y and X-Z planes, therefore the use of Equation 2.73 to work out the axial velocity at any point may be a mistake. Even after each velocity and chemical concentration has been found out, the total flux will be very difficult to analyze since the axial velocity and chemical concentration profiles will not be symmetrical. It causes disparate velocity and chemical concentration at any point in the jet. A much more complex model would be required which is beyond the scope of study.

The F (C/C_o vs. t) curve can be developed using the chemical species (total flux) conservation as shown in Equation 2.34. Basically, the flow development area formed by the jet can be divided into many small elements. Each element has a concentration and a velocity. At a certain distance (outlet point), it is assumed that there is an imaginary plane. Every element that hits the plane is assumed to be removed to the outlet point directly. Total flux (total velocity times area times chemical concentration) should be the same as that at the initial point as the chemical is conservative. As a relative concentration is used where at the steady state condition $C/C_o = 1$, total flux at the outlet point should be the same as the initial flow (velocity times area). The C/C_o vs. time curve can be developed by dividing each total flux at any time by the initial flow.

For this study, reservoirs no.2 and 3 were analyzed using the jet model (see Chapter 6.0), and it was found that the existing jet models discussed earlier seemed to fit the observed data adequately. Reservoir no.1 was not analyzed using this model as there

is a baffle in front of the inlet point. During the tests, water surface for reservoirs no.2 and 3 covered some parts of the pipe inlets. An imaginary diameter can be used by assuming the equivalent diameter for the same cross section area of water in the pipe. Rajaratnam and Pani (1974) conducted experiments using several types of nozzles (square, triangle, circular, and elliptic) to analyze the three dimensional turbulent wall jet, and stated that the surface turbulent jet should behave similarly. By maintaining the initial velocity (U_0) constant, it was found that velocity profiles along the jets were roughly the same. Knowing that U_0 is basically based on the area of the nozzle (assuming that the flow is constant), it is acceptable to assume that for the same nozzle area, the shape will not affect the initial velocity behavior. The imaginary diameter was calculated for each test since the water level changed for each test.

In order to do the analysis, it is assumed that the maximum velocity and concentration profiles follow the circular surface turbulent jet (Equations 2.84 and 2.90), but the velocity and chemical concentration profiles under the water surface follow the circular submerged condition (Equations 2.54 and 2.56). As the amount of flux should be constant, it is acceptable to "flip" the top part of the jet to below the water surface forming a half - circular shape (Metcalf and Eddy, 1991). Note: in the real mathematical hydraulic problem, even the momentum flux is not constant since the ambient pressure is not constant either (Kotsovinos and Angelidis, 1991). The half - circular shape can be used to calculate the total flux. Angles of 0° to 10° from the center line of the jet with 1° increment were used. It was found that up to 10°, the total flux already reached a value of almost 100%. The velocity and chemical concentration profiles have symmetrical shapes. The average is made for the velocity and chemical concentration with the adjacent layers (say between 2° layer and 1° layer). The area of the half - circular layer can be obtained easily = $0.5\ \pi\ (r_2 - r_1)^2$, where r_2 and r_1 are the radius of the adjacent layers (see Figure 2.8).

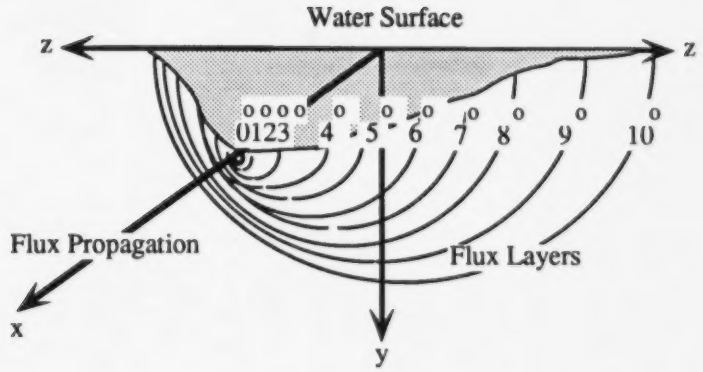


Figure 2.8: Total Flux

This simplification cannot be applied to figure out a particular velocity or chemical concentration at any point in the jet. Although the analysis is not ideal, it still should be valid for the total flux since basically the same total flux will travel, no matter what the velocity or chemical concentration profile is. The analysis is supposed to be able to indicate whether the momentum effect from the inlet was responsible for the rapid travel of the tracer through the reservoir.

More studies about jet theories in shallow or confined water surfaces have been done by Johnston and Halliwell (1986), Sobey et al (1989), Johnston (1990), and Johnston and Volker (1993). Basically, they classify two types of jets travelling in shallow waters: bed and surface jets. The difference between the two is that the jet mainstream flows in the bottom part and in the top part of the water, respectively. The center line velocity decrease for the bed jet seems to be large compared to the free jet, while the surface jet's decrease is less. However, the investigations are only in preliminary stages. Exact parameters have not been identified yet, especially for the chemical concentration.

2.3.6 Simplified Jet Model

Further simplification of the jet model provides another useful tool for analysis. This assumes that the maximum axial velocity contributes the most effect to predict the t_{10}. There is a constant (C_1) that is applicable for a particular distance (l). The change in the axial velocity is given by:

$$du = \frac{dx}{dt} = \frac{U_o C_1 d_o}{x} \qquad (2.91)$$

set: x = l (length of the system) and $t = t_{10}$, the integration yields:

$$t_{10} = \frac{l^2}{d_o\ U_o\ C_1} \qquad (2.92).$$

As will be shown later in Chapter 6.0, C_1 was found to be relatively constant. This simplified form is very useful to make a rough guess of the t_{10} even before the test has been undertaken. Time intervals of the sampling can be arranged to be very small near the important point (the predicted t_{10}) but rather long for other points. This relation can also be used to predict the t_{10} at different flow rates.

2.4 t_{10} Values for Different Flow Rates

After a particular t_{10} value has been found using either the residence time distribution methods (the E and F curves) or the jet method, the next problem is to interpret different t_{10} values from different flow rates without conducting further tracer tests. The Guidance Manual (1989) suggests conducting at least four tracer tests for each system using four flow conditions, one near, two greater, and one below the average flow. The highest one should be at least 91% of the peak flow. Correlation between the t_{10} values and the flow rates should form a curve. Still, only one test at the flow at least 91% of the peak flow is accepted due to practical limitations (Guidance Manual, 1989). Other t_{10} values for different flow rates can be predicted using this ratio:

$$\frac{t_{10t}}{t_{10d}} = \frac{Q_d}{Q_t} \qquad (2.93)$$

where:

t_{10t} = t_{10} obtained from tracer study (min.)

t_{10d} = t_{10} at desired flow (min.)

Q_t = flow at tracer study (ML/min.)

Q_d = desired flow (ML/min.).

As has been mentioned above, correlation between the t_{10} and Q values is not linear. Yu et al (1990) show that the correlation can be exponential as follows:

$$t_{10} = \alpha Q^{\beta} \qquad (2.94)$$

where α and β are regression coefficients. It can be concluded that Equation 2.93 will give very conservative results. This seems to agree with another statement mentioned in the Guidance Manual (1989) that the extrapolations are allowed in lower parts of the four points given (see Figure 2.9). A slightly different approach is given by Hart and Gupta (1978) as they tried to correlate the t_{50}/T_d and t_a/T_d with the Q (flow) as a linear function with α and β as linear regression coefficients:

$$\frac{t_{50}}{T_d} \text{ or } \frac{t_a}{T_d} = \alpha Q + \beta \qquad (2.95).$$

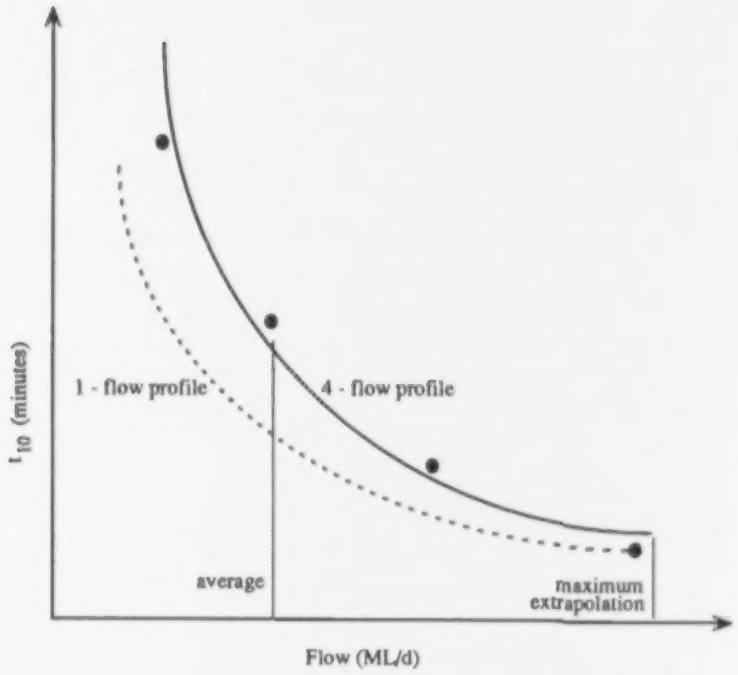


Figure 2.9: t_{10} Values vs. Flow Rates (adapted from the Guidance Manual, 1989)

3.0 CASE STUDY

3.1 Treatment Plant Operation

The E. L. Smith Water Treatment Plant is located on the upstream edge of the City of Edmonton, Alberta. It was built in 1976 with a capacity of 180 - 220 ML/d. Expansion of the plant is currently planned to achieve a capacity of 360 ML/d. The plant, shown in Figure 3.1, uses the following processes: alum coagulation, clarification, chlorine dioxide disinfection, fluoridation, partial softening with lime and recarbonation, rapid sand filtration, and chloramine disinfection to provide a residual.

Under normal operating conditions, the plant is operated in a split flow configuration. Raw water enters the plant from the North Saskatchewan River through low lift pumps. Flow rate is measured using a venturi device meter. The water is dosed with alum and ammonia and then split between the first two clarifiers (C1 and C2) where flocculation and clarification occurs. The effluent from both clarifiers is contacted with the primary disinfectant, chlorine dioxide, prior to its entering the third clarifier (C3) where lime softening takes place. Effluent from C3 is dosed with chlorine which reacts with previously added ammonia to form chloramines. The water is then sent to the recarbonation chamber for pH adjustment and then distributed to the filters. The filtered water is distributed to three on - site reservoirs. High lift pumps send the final water to the distribution system.

The treatment plant operates under a licence from the province of Alberta. This license requires the plant to stay within the Guidelines for Canadian Drinking Water Quality and sets out some additional water quality requirements that should be fulfilled. The treated water quality values including the plant operating ranges can be seen in Table 3.1 (Simpson, 1989).

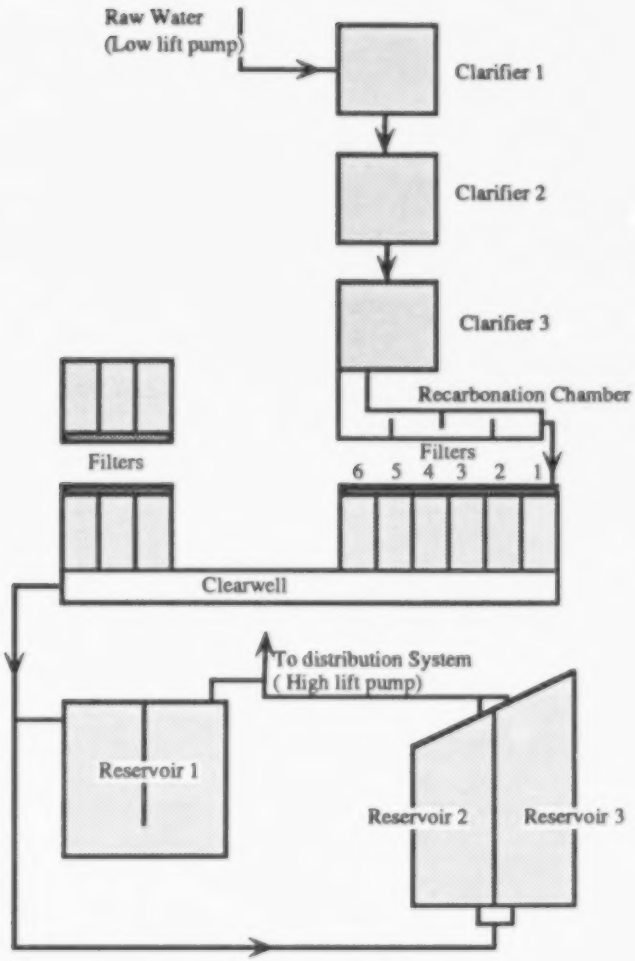


Figure 3.1: E. L. Smith Water Treatment Plant Layout (adapted from Stanley et al, 1993)

Table 3.1: Treated Water Quality Values (adapted from Simpson, 1989)

Parameter	Operating Range	Objective Range	Licence Requirement
Turbidity	≤ 0.5 NTU	≤ 1.0 NTU	≤ 1.0 NTU
Color	≤ 2 TCU	≤ 5 TCU	≤ 15 TCU
pH	8.0 to 8.4	6.5 to 8.5	6.5 to 8.5
Combined Cl Residual [1]	1.8 to 2.2 mg/L	1.8 to 2.4 mg/L	≥ 1.8 mg/L
Fluoride	0.9 to 1.1 mg/L	0.8 to 1.2 mg/L	0.8 to 1.2 mg/L
Total ClO_2 Oxidants [2]	0.2 to 0.4 mg/L	0.2 to 0.5 mg/L	≤ 0.5 mg/L
THMs	≤ 0.005 mg/L	≤ 0.01 mg/L	≤ 0.35 mg/L
Total Coliform	≤ 1/100 mL	≤ 1/100 mL	≤ 10/100 mL
Fecal Coliform	0	0	0
Aggressiveness Index	≥ 11.5	≥ 11.5	------
Total Hardness [3]	110 to120	105 to 125	------
Volatile Organics	0 to 0.005 mg/L	0 to 0.01 mg/L	------
UV Absorbances [4]	0 to 5 mg/L	0 to 10 mg/L	------

1) mostly monochloramine
2) mostly chlorite
3) in mg $CaCO_3$ /L
4) as humic acid equivalents

3.2 Previous Study

The Process Development Team undertook tracer studies for the E. L. Smith and Rossdale Water Treatment Plants in 1989 - 1990. The objective of the study was to investigate the compliance of the systems to the SWTR / CT concept. These studies showed that both treatment plants were likely to meet the overall inactivation of Giardia cysts and viruses in summer conditions but not in winter conditions.

In the case of the E. L. Smith Water Treatment Plant, sodium chloride and fluoride were used as the tracers. However, the tests were relatively limited since not all of the E or F curves reached the steady or balance conditions (shorter sampling times) and less sampling points were taken. Only the effluent points were monitored. Therefore, in the case of reservoir test, only the combined result was obtained, not for the single process. Chlorine dioxide was collected from clarifier no. 3 effluent to get the CT value for the clarifier, while chloramine was monitored in the combined reservoir effluent to obtain the CT value for the reservoirs (Process Development Team, 1991).

3.3 Research Objectives

Based on the Process Development Team results, it was recommended that additional tests be conducted to improve the accuracy of the results. Since their tests assessed the overall performance of the plant, but not individual components, it was almost impossible to determine what components should be modified to most efficiently improve the overall contact time of the plant. Finally, the City of Edmonton also wanted to assess the effect of plant expansion on disinfection contact time.

With the above points in mind, research objectives of this study are as listed below:

1) develop accurate residence time distributions for components of the E. L. Smith Water Treatment Plant,

2) determine the residence time distribution for each component to prioritize possible modifications, and
3) develop models that are capable of predicting the residence time distribution in view of plant expansion.

4.0 METHODS AND MATERIAL

4.1 Tracer Input

Step and slug inputs are the most common methods of injecting the tracer to the system. They have been used as early as the 19th century. The step input, known as the "Lawrence continuous method", was introduced for the first time in 1890, while Clifford suggested the addition of a momentary high dose of tracer in 1905 (Taras, 1956). Theoretically, both of them give the same results with the same accuracy. Still, in a practical situation, a decision should be made to choose the most appropriate method.

The slug input has two advantages, relatively shorter time is spent and relatively small amount of tracer is used in the test. It can lower the cost and health concerns. Unfortunately, the slug input has a number of disadvantages both during the test and the data analysis. The tracer should be added as fast as possible. As has been mentioned in the previous chapter, it should be added in a period less than $T_d/50$ (Thirumurthi, 1969). While Joost et al (1991) suggest to add the tracer in less than one minute. In the case of sodium chloride, when a very high salt concentration is needed, a very intensive mixing is required. Otherwise the high density salt solution will diffuse slowly in the water, or will settle to the bottom of the system (Taras, 1956). Hudson (1975) found that during his tests, the slug input never gave good tracer recoveries. There are many problems found in the data analyses as well. More mathematical manipulations are needed, including normalization of the E curve using Equation 2.4 and a material balance check using Equation 2.5.

The step input has a primary benefit that there is no mathematical manipulation required. As t_a cannot be obtained directly from the F curve (it should be transposed back to the E curve using Equation 2.12), usually T_d is used to avoid the manipulation.

One disadvantage of the step input is that the tracer should be added over a relatively long period of time. As has been mentioned in the previous chapter, at least 2 or 3 times T_d (Hudson, 1975). As a consequence, it needs feed equipment that is capable of distributing the tracer continuously in a constant flow for hours or even days. Concerns like cost and health are not significant as many inexpensive and safe chemical compounds are available. Overall, the step input is considered to be better than the slug input, and it is therefore recommended by the Guidance Manual (1989).

4.2 Tracer Compound

Many chemical compounds have been tried as tracers. However, fluoride, Rhodamine WT®, and sodium chloride seem to be the most popular ones. The Guidance Manual (1989) and Joost et al (1991) give some explanations about selecting chemical compounds. Basically it has to follow certain criteria, including:

1) readily available and inexpensive,
2) conservative or stable, not removed nor consumed in the water process,
3) easily analyzed, and
4) acceptable to use in potable water supplies. Dyes or radio active compounds that may be harmful for health are not recommended, for example: Rhodamine B.

Fluoride is a very popular choice. However, it is a relatively hazardous material in its most commonly used form, H_2SiF_6 (hydrofluosilicic acid). Gloves and face shields are required to handle it. The use of fluoride can be very convenient if the treatment plant has already added it for health reasons. A relatively easy analysis can be done using a specific ion probe for fluoride. As the maximum contaminant level (MCL) for this chemical compound is only 4 mg/L, some water with relatively high fluoride concentration will prevent the use it. One disadvantage of using fluoride is its difficulty to monitor at concentrations less than 0.05 mg/L (Dunn et al, 1991). However,

VandeVenter et al (1991) who used an Orion model 1809 on - line fluoride analyzer were able to measure the fluoride concentration in the range of 0.01 to 100 mg/L directly on site. However, the reaction of fluoride with alum is a concern which limits the use of this chemical compound (Hudson, 1975 and Teefy and Singer, 1990).

Rhodamine WT® is one type of fluorescent dye which is commonly used as a tracer. The MCL in drinking water is 0.1 µg/L. Only a small concentration is needed as there is not any fluorescence background in most source water. A fluorometer can be used to measure the concentration accurately and rapidly. Hart (1975) considers it as a good tracer, since it is detectable at low concentration (0.01 ppb) using a Turner Model III Fluorometer, turbidity has very little effect on the fluorosence response, and it is very stable especially in the pH range of 5 to 10. However, Rhodamine WT® reacts with free chlorine which may prevent the use of this type of tracer.

Sodium chloride is probably the best type of tracer to use. As a common salt (NaCl), it is available in very high concentrations at a relatively low cost. It is very conservative, easy to use (it freezes below -20° C) and measure, and not generally considered toxic (the Merck Index, 1989). Probably the only problem is that sodium chloride is a very common chemical compound found in natural water. A very high background concentration may prevent the use of it. The MCL in receiving water is 250 mg/L, however Alberta Environmental Protection stipulates a maximum concentration of only 20 mg/L.

Another type of chloride salt like lithium chloride is mentioned by Joost et al (1991) as an expensive chemical compound which is slightly difficult to analyze, while Leland et al (1990) tried to use calcium chloride in their experiments. Kennedy et al (1993) do not recommend the use of chlorine as it reacts with other chemical compounds in water. Qualls and Johnson (1983) explain the formulae for chlorine decay due to fulvic acids. Similar to fluoride, chlorine can be somewhat convenient to use if it is

already added to the system as disinfectant. However, unlike fluoride, direct measurement of chlorine is necessary to avoid its decay rate (Kennedy et al, 1990).

Other types of tracer have been used as well, however they do not seem suitable to apply in drinking water studies due to health concerns. Biological tracer like coliform bacteria is one idea. A study conducted by Polpraset and Bhattarai (1985) shows that coliform decay in the system can be well correlated with the dispersion index. Agunwamba (1992) used coliform bacteria to measure the dispersion number in a waste stabilization pond. Bromide has been tried as well by Hagerman et al (1989), while Sawyer and King (1969) and Mitha and Mohsen (1990) used methylene blue dye to analyze the hydraulic performance of small - scale pilot tanks.

4.3 Measurement Method

Standard Methods (1992) gives three methods to measure sodium ions in samples. The atomic absorption spectrometric method basically measures the amount of light absorbed. The light is directed to the flame, into a monochromator, and then measured by a detector. The flame emission photometer method uses a similar concept, but the sample is aspirated and atomized, and then the amount of light emitted is measured directly. The trace of sodium can be determined at a wave length of 589 nm. The third choice is the ICP emission spectroscopy method. It utilizes of a flowing stream of argon gas that is ionized by an applied radio frequency field. The sample is injected into the ICP and dissociates into atoms due to the high temperature. The light wave length emitted from the ICP is examined by a spectrometer. Complete descriptions for those three methods can be found in the Standard Methods for the Examination of Water and Wastewater (1992).

Among these three methods, the flame emission photometer method seems to be the most suitable one. It is easy, inexpensive, and fast to analyze. It needs less chemical

preparation and gives good results. Interference from other ions is probably the main concern. However, in the case of tracer studies for water treatment plants, this concern is not significant as the water analyzed is generally in an excellent quality.

4.4 Tracer Recovery

In the case of conservative tracer compounds, 100% tracer recovery should be obtained for every single test. However, problems are encountered in real situations that may affect the recovery, such as losing some amount of tracer in the system or imperfection of the modeling. The Guidance Manual (1989) suggests that at least 90% tracer recovery should be obtained in each test. Basically, the recovery can be found using this equation:

$$\% \text{ Recovery} = \frac{C_f Q}{C_b Q + C_t q_t} \qquad (4.1)$$

where:

C_f = final concentration at steady state, including background (mg/L)

C_t = tracer concentration (mg/L)

C_b = background concentration (mg/L)

q_t = tracer flow (L/min.)

Q = water flow (L/min.).

5.0 TEST PROCEDURES AND RESULTS

5.1 Test Procedures

The samples were taken at the treatment plant for filters nos. 1 to 6, clarifier no. 2, and all of the three reservoirs. In total, there were ten tests conducted from February 16, 1993 until June 30, 1993 for different periods of time (3 to 52 hours) and in different types of flow (141 to 230 ML/d or 64% to 105% of the peak flow). The tracer recoveries ranged from 84% to 107% (see Tables 5.1 and 5.2).

Food grade sodium chloride (NaCl) in a saturated solution (131,000 mg/L) was added to the system in a step input. Since the background concentration was about 4 mg/L, the tracer feed was set to add about 15 mg/L of brine in order not to violate the 20 mg/L maximum concentration of salt in the receiving water. A constant head tank was used to maintain the continuity and stability of the tracer flow during the tests. The brine was pumped from a 60,000 L outdoor storage tank to a 2,500 L indoor storage tank. The brine then was circulated to the constant head tank using another pump before being added to the inductor. Since the brine flow was only in the range of about 0.2 to 0.3 L/s, potable water was needed to flush it into the system (see Figure 5.1).

More than 2,700 samples were taken in several locations. In the case of filter test no. 1, six inlet sampling points were chosen right in the beginning of the filters nos. 1 to 6, six outlet sampling points were located at the end of the six filters before the clearwell, and one sampling was taken in the end of the clearwell. The same sampling points were taken during test no. 2, but the inlet points were not taken as the previous test indicated that the flow was evenly distributed to each filter. Test no. 3 was conducted in clarifier no. 2. Two sampling points were located at the top and bottom of the draft tube, four sampling points at the top parts of the clarifier, one point in the

Table 5.1: Samples Taken

TEST #	1
Location	Filters+Clearwell
Date	16-Feb-93
Sampling Time	03:05:00
Flow (ML/d)	180
SAMPLE	**NUMBER**
Filter 1 Inlet	26
Filter 2 Inlet	26
Filter 3 Inlet	23
Filter 4 Inlet	24
Filter 5 Inlet	23
Filter 6 Inlet	22
Filter 1 Outlet	31
Filter 2 Outlet	29
Filter 3 Outlet	29
Filter 4 Outlet	29
Filter 5 Outlet	33
Filter 6 Outlet	33
End of Clearwells	55
Tracer	1
Total	384

TEST #	2
Location	Filters+Clearwell
Date	24-Feb-93
Sampling Time	03:06:30
Flow (ML/d)	140
SAMPLE	**NUMBER**
Filter 1 Outlet	34
Filter 2 Outlet	35
Filter 3 Outlet	31
Filter 4 Outlet	31
Filter 5 Outlet	35
Filter 6 Outlet	36
End of Clearwells	54
Tracer	1
Total	257

TEST #	3
Location	Clarifier 2
Date	05-Mar-93
Sampling Time	03:04:00
Flow (ML/d)	180
SAMPLE	**NUMBER**
Effluent	44
Bottom Clarifier 1	43
Bottom Clarifier 2	43
Manhole	46
Point 1	45
Point 2	45
Point 3	45
Point 4	45
Tracer	1
Total	357

TEST #	4
Location	Reservoir 1
Date	24-Mar-93
Sampling Time	12:35:00
Flow (ML/d)	180
SAMPLE	**NUMBER**
Inlet	49
Outlet	78
Backround	6
Tracer	4
Total	137

(cont'd)

TEST #	5
Location	Reservoir 2
Date	06-Apr-93
Sampling Time	15:00:00
Flow (ML/d)	167
SAMPLE	NUMBER
Inlet	55
Outlet	90
Backround	13
Tracer	7
Total	165

TEST #	6
Location	Reservoir 2
Date	20-Apr-93
Sampling Time	14:16:00
Flow (ML/d)	141
SAMPLE	NUMBER
Inlet	45
Outlet	85
Backround	14
Tracer	7
Total	151

TEST #	7
Location	Reservoir 3
Date	28-Apr-93
Sampling Time	14:00:00
Flow (ML/d)	179
SAMPLE	NUMBER
Inlet	52
Outlet	84
Backround	14
Tracer	7
Total	157

TEST #	8
Location	Reservoir 1
Date	18-Jun-93
Sampling Time	09:00:00
Flow (ML/d)	230
SAMPLE	NUMBER
Inlet	45
Outlet	53
Backround	10
Tracer	6
Total	114

TEST #	9
Location	Reservoir 3
Date	25-Jun-93
Sampling Time	09:30:00
Flow (ML/d)	198
SAMPLE	NUMBER
Inlet	46
Outlet	63
Backround	11
Tracer	6
Total	126

TEST #	10
Location	Reservoir 1,2,3
Date	30-Jun-93 until 02-Jul-93
Sampling Time	52:25:00
Flow (ML/d)	170
SAMPLE	NUMBER
Inlet 1	83
Inlet 2	33
Outlet 1	138
Outlet 2	126
Outlet 3	131
Convergence	309
Background	50
Tracer	27
Total	897

GRAND TOTAL=	2745

Table 5.2: Test Data

Location	Water Flow (ML/d)	Water Level (m)	Water Volume (m^3)	Na Backgr (mg/L)	Na Final (mg/L)	Tracer[1] Flow (L/s)	Tracer[2] Recovery (%)	T_d (min.)
Filters+Clearwell	180	-	3642	3.72	14.58	0.27	88	29
Filters+Clearwell	140	-	3642	2.62	12.48	0.19	84	37
Clarifier No. 2	180	-	10700	3.59	09.61	0.14	107	86
Reservoir No.1	180	4.1	37140	4.04	12.68	0.22	94	297
Reservoir No.1	230	3.9	35120	3.08	13.57	0.32	86	220
Reservoir No.2	141	3.6	28570	3.92	14.08	0.19	94	292
Reservoir No.2	167	4.0	32050	4.87	12.48	0.18	102	276
Reservoir No.3	179	3.6	35178	4.39	12.07	0.19	100	283
Reservoir No.3	198	4.4	43762	3.47	13.31	0.28	86	318
Reservoirs Nos.1,2,3	170	-	106640	4.52	13.88	0.26	84	926[3]
Reservoir No.1=20%	34	3.9	35120	-	-	-	-	-
Reservoir No.2=38%	65	4.0	32050	-	-	-	-	-
Reservoir No.3=42%	71	4.0	39470	-	-	-	-	-

1) Sodium chloride (NaCl) in a step input was used for all tests.

2) Brine concentration = 131,000 mg/L Na.

3) Including 760 m pipe system with diameter = 2.1 m, assuming PFR.

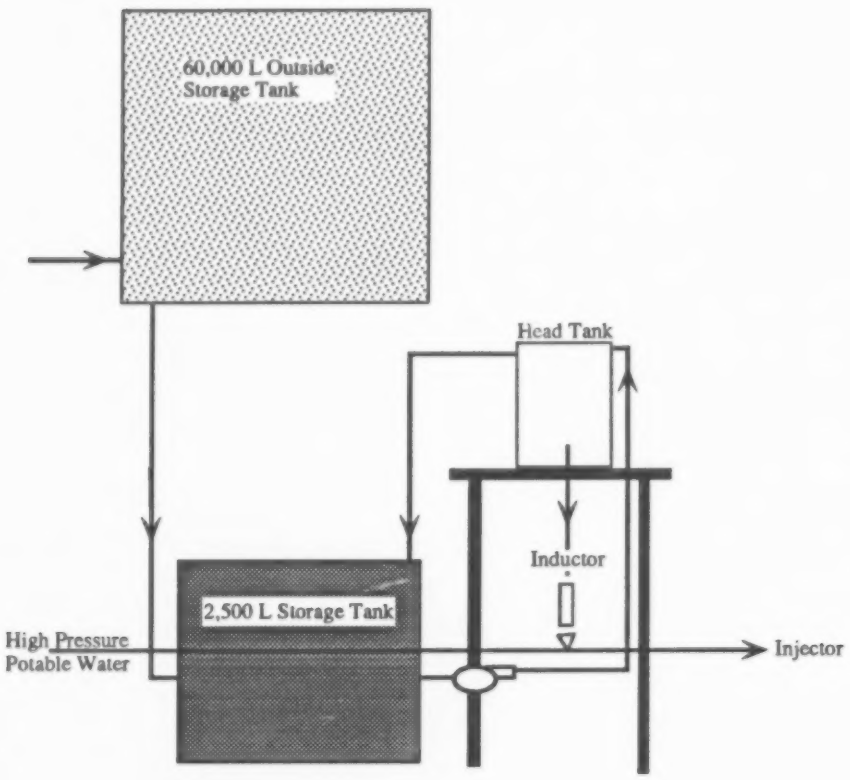


Figure 5.1: Brine Input System (adapted from Stanley et al, 1993)

manhole, and one point at the effluent. For single reservoir tests, (tests nos. 4 to 9), only the inlet and outlet of each reservoir were taken. The last test (test no.10) was conducted for all of those three reservoirs operating in parallel. Two inlet points at reservoirs nos.1 and 2, three outlet points at all of the reservoirs, and one point at the convergence point were chosen as the sampling points. Initial samples were taken for all of the tests, while background samples were taken for tests nos. 4 to 10. Figures 5.2 to 5.4 show the sampling locations for all the tests.

It is important to consider the injection location of the tracer. For all of the ten tests, the points were located at good locations where immediate mixing would occur to avoid the slow diffusing of brine in water. In the case of filters and clearwell tests, the brine was injected at the OG weir at the end of the recarbonation chamber. For the clarifier test, the injection point was located at the rapid mixing point of the raw water in the influent line of the clarifier. In the case of reservoir tests, the brine was flushed right into the clearwell where there is complete mixing (see Figures 5.2 to 5.4). It is possible to calculate the amount of brine needed for all tests after knowing the duration and the tracer velocity for each test (Tables 5.1 and 5.2). There was about 150,500 L of brine required for all of the tests.

Although 2 to 5 minute sampling intervals (from when the first tracer is monitored until the steady condition) are recommended by the Guidance Manual (1989), it was found that the most efficient use of samples were to concentrate them near the expected t_{10}. As a result, early in the test, a sample interval of 1 to 5 minutes was used. After the curve was almost or had already reached the steady state condition (based on estimation), 10 to 20, or even 60 minute sample intervals were used. The samples were taken both manually and automatically using three auto - samplers. Large plastic bottles (250 mL) were used to collect samples in the first test. As the analyses required only a small amount of water, 20 mL small teflon bottles were used for the other tests.

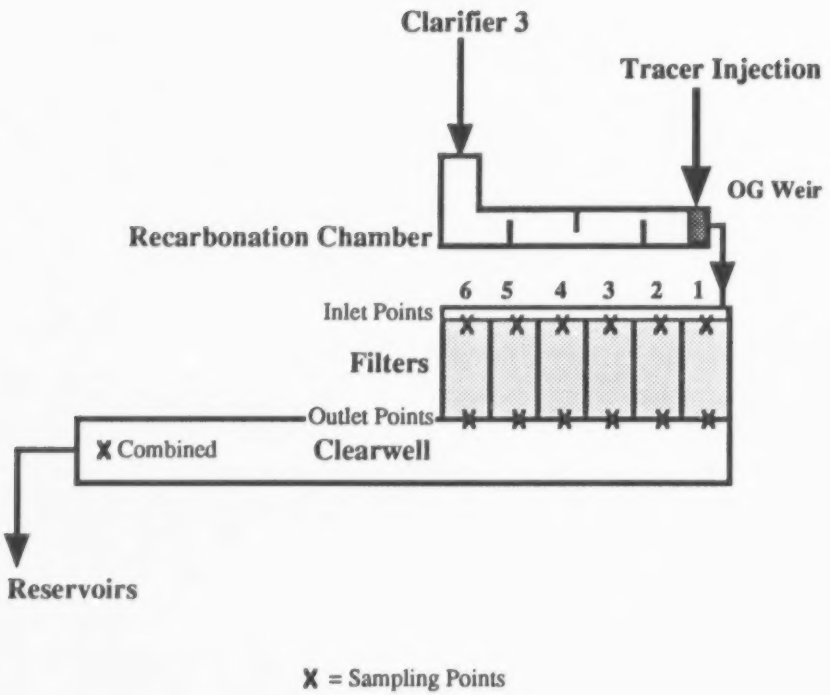


Figure 5.2: Sampling Locations for Filters and Clearwell (Tests Nos. 1 and 2)

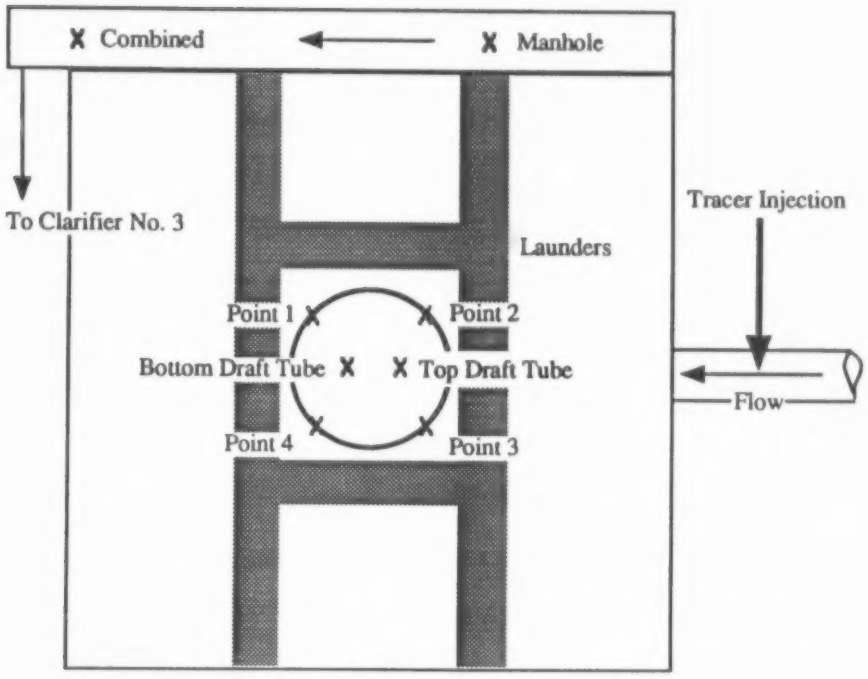


Figure 5.3: Sampling Locations for Clarifier No. 2 (Test No. 3)

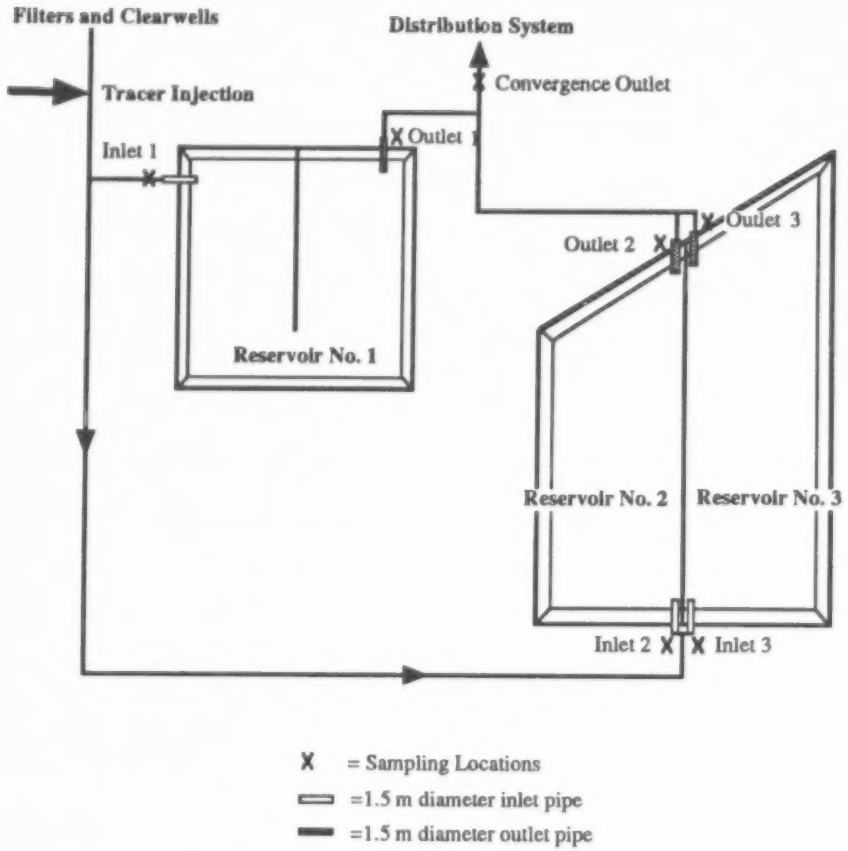


Figure 5.4: Sampling Locations for Reservoir (Tests Nos. 4 to 10)

Analyses were done at the Environmental Engineering and Science Laboratory located at the University of Alberta using a flame emission photometer according to the Standard Method 3500-Na D (Standard Methods, 1992).

Several standard solutions of sodium in the range of 0 mg/L to 20 mg/L were made. The instrument readings were calibrated from the scale of 0 to 100. It is assumed that the correlation between the readings and the standard concentrations is linear. The linear regression method was used to determine the linear equation.

5.2 Curve Development and Error Factors

The final tracer concentration, or equal to the initial amount of tracer added (C_o), was chosen from the steady condition of the inlet / influent concentration. All the inlets / influents reached the steady conditions, but not all the outlets / effluents. Tracer concentration at the clearwell point from tests nos. 1 and 2 did not reach steady conditions. The reason is that there was some water coming into the sampling point in the clearwell from the other filter bank (see Figure 3.1 above). This may explain the noise at the end of clearwell sampling points (see Figures 5.5 and 5.6). Test no. 9 did not last long enough to reach the steady condition for the outlet. Probably two more hours would give a better result. Some judgements should be made when the background increased for test no. 4. The steady condition for the inlet was assumed to happen before the noise.

It was assumed that the end points of the curves became the steady state values, while the initial values were found from the background samples. The F(t) vs. t curves were generated using Equation 2.9 (see Appendix 1). The theoretical residence time (T_d) can be determined based on the incoming flow and the system volume using Equation 2.3. All of the F curves can be seen in Figures 5.5 to 5.14.

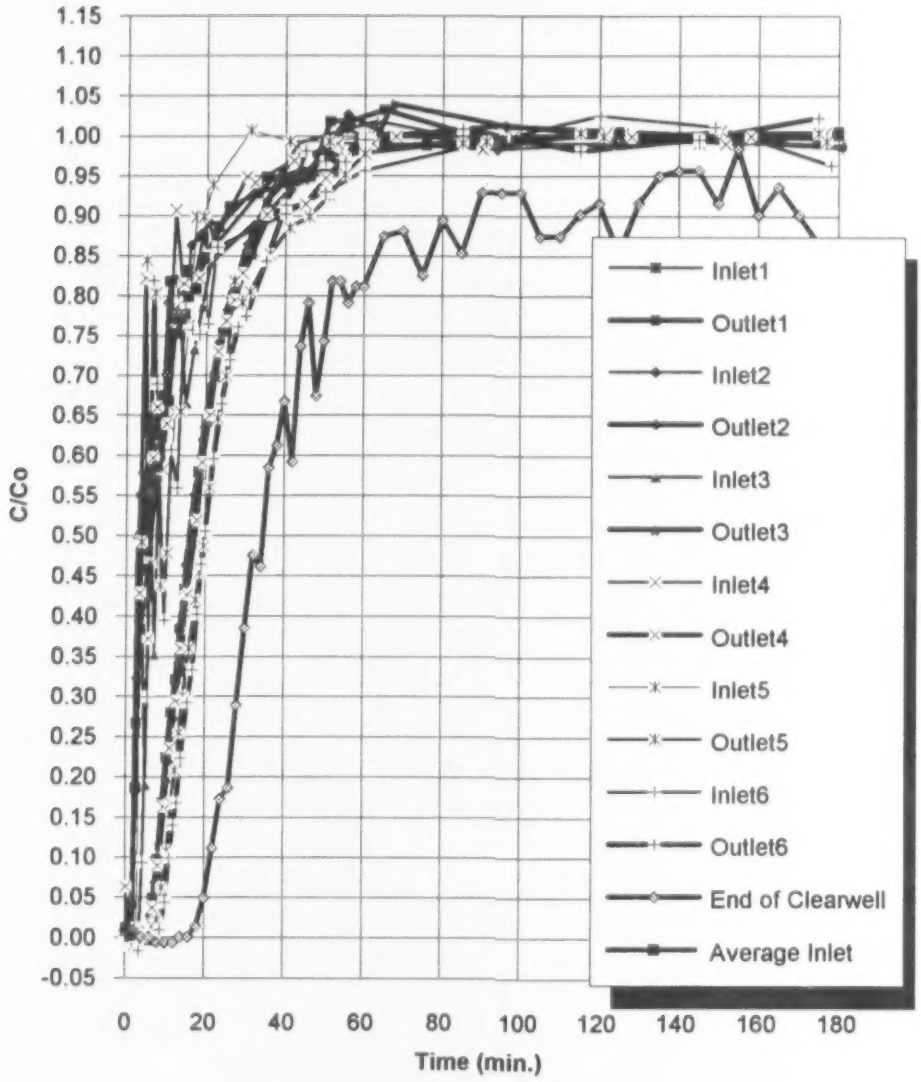


Figure 5.5: Test No.1 - Filters and Clearwell at 180 ML/d

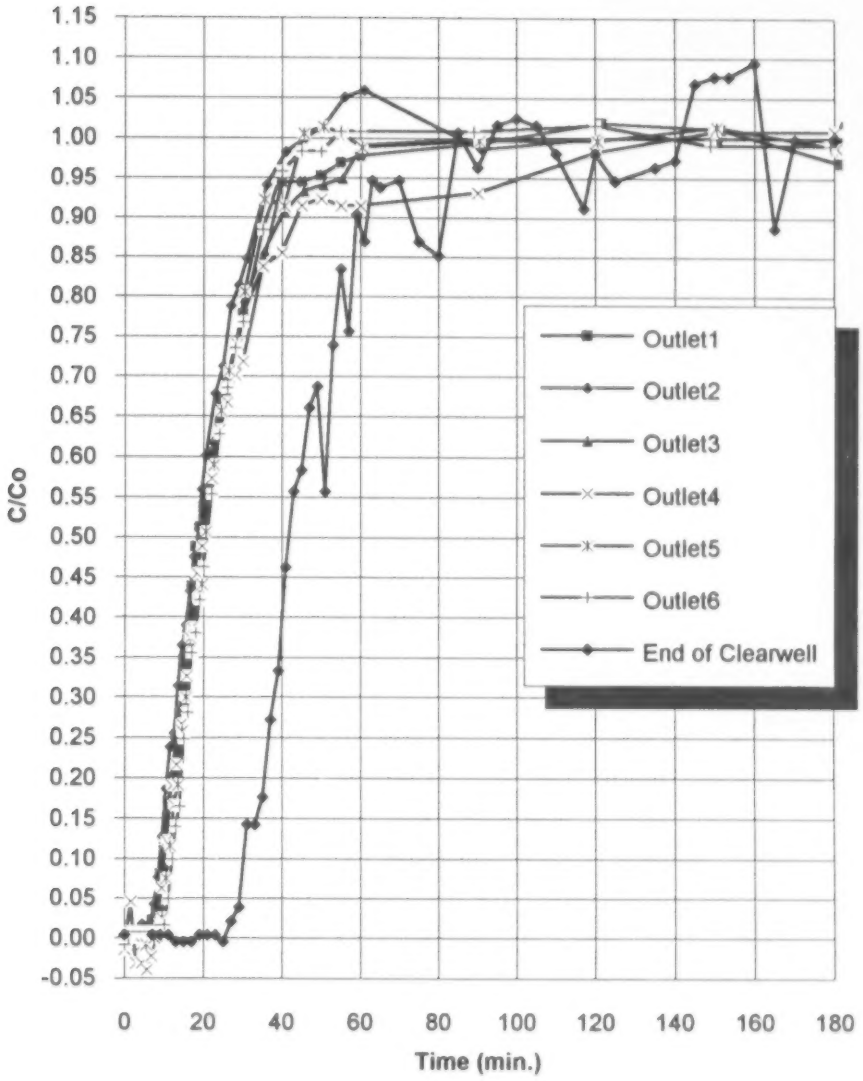


Figure 5.6: Test No.2 - Filters and Clearwell at 140 ML/d

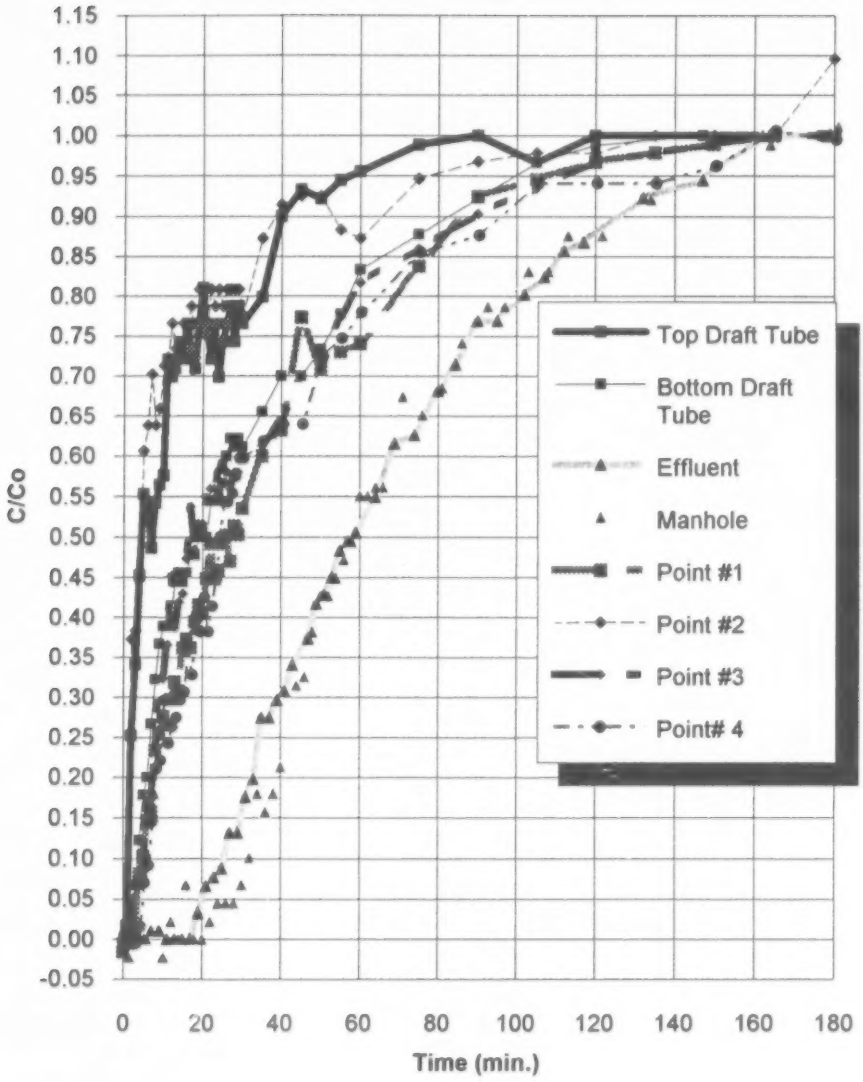


Figure 5.7: Test No.3 - Clarifier No. 2 at 180 ML/d

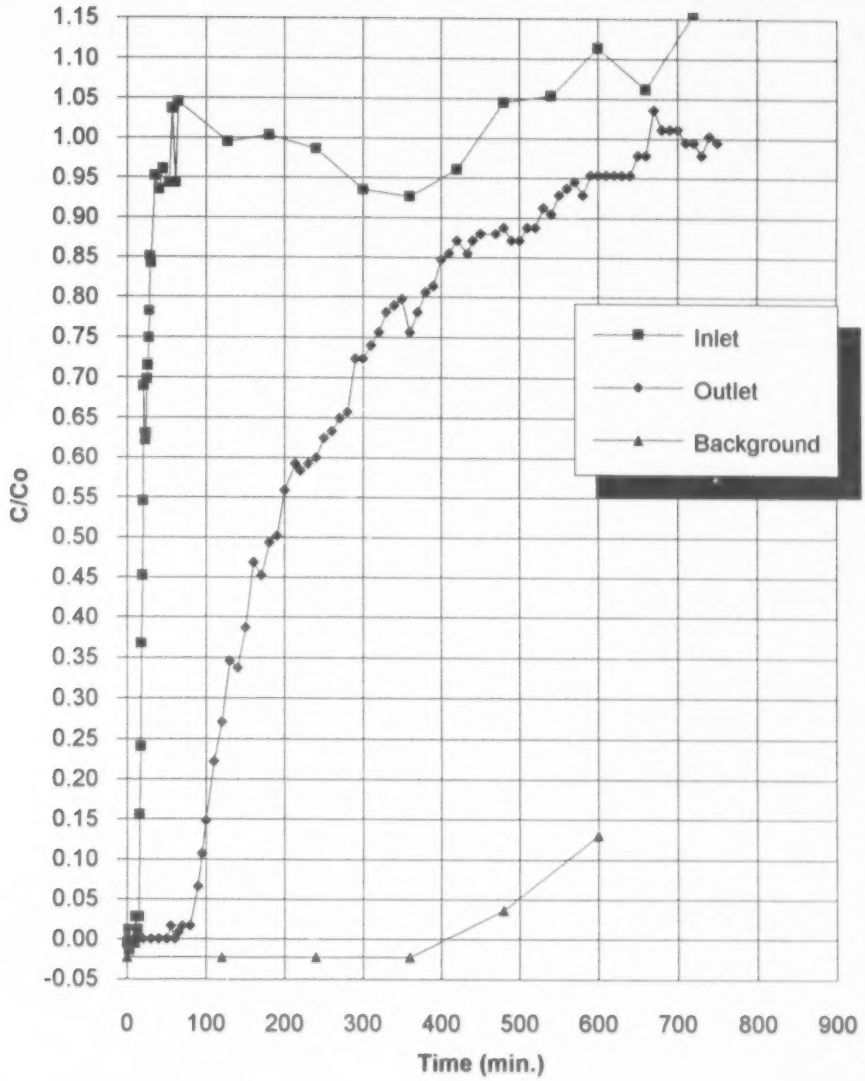


Figure 5.8: Test No.4 - Reservoir No. 1 at 180 ML/d

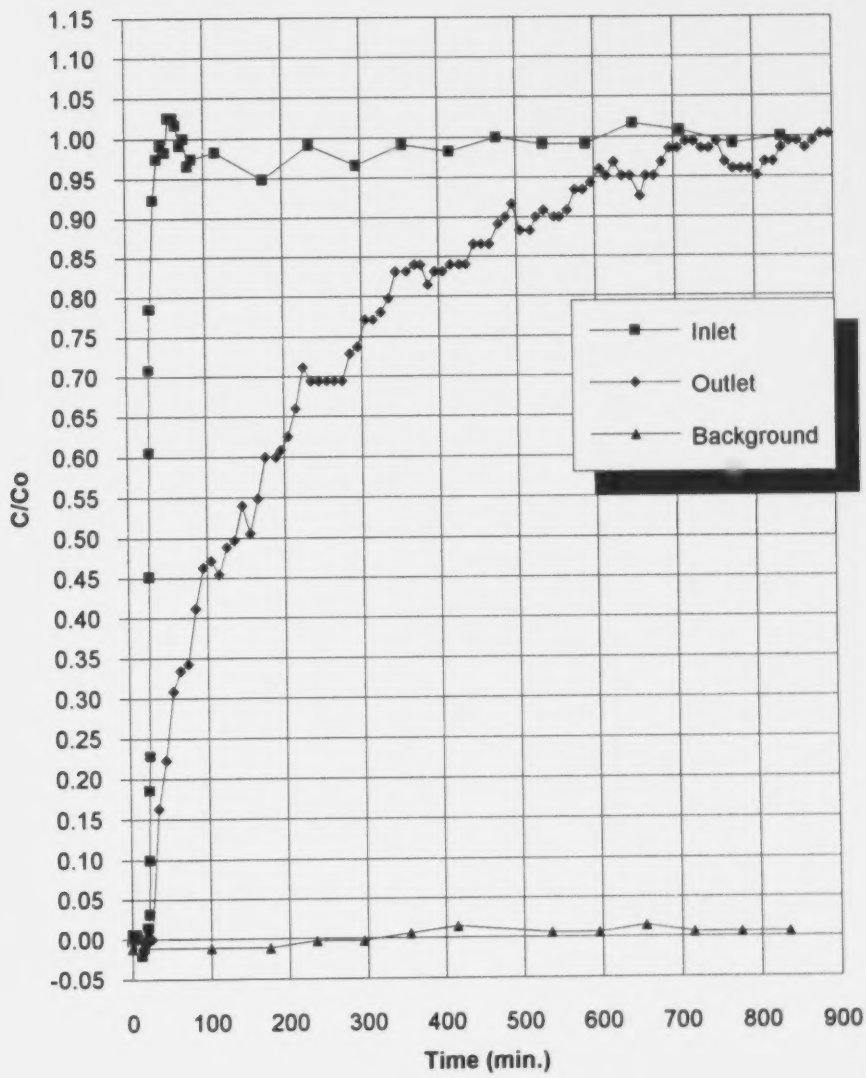


Figure 5.9: Test No.5 - Reservoir No. 2 at 167 ML/d

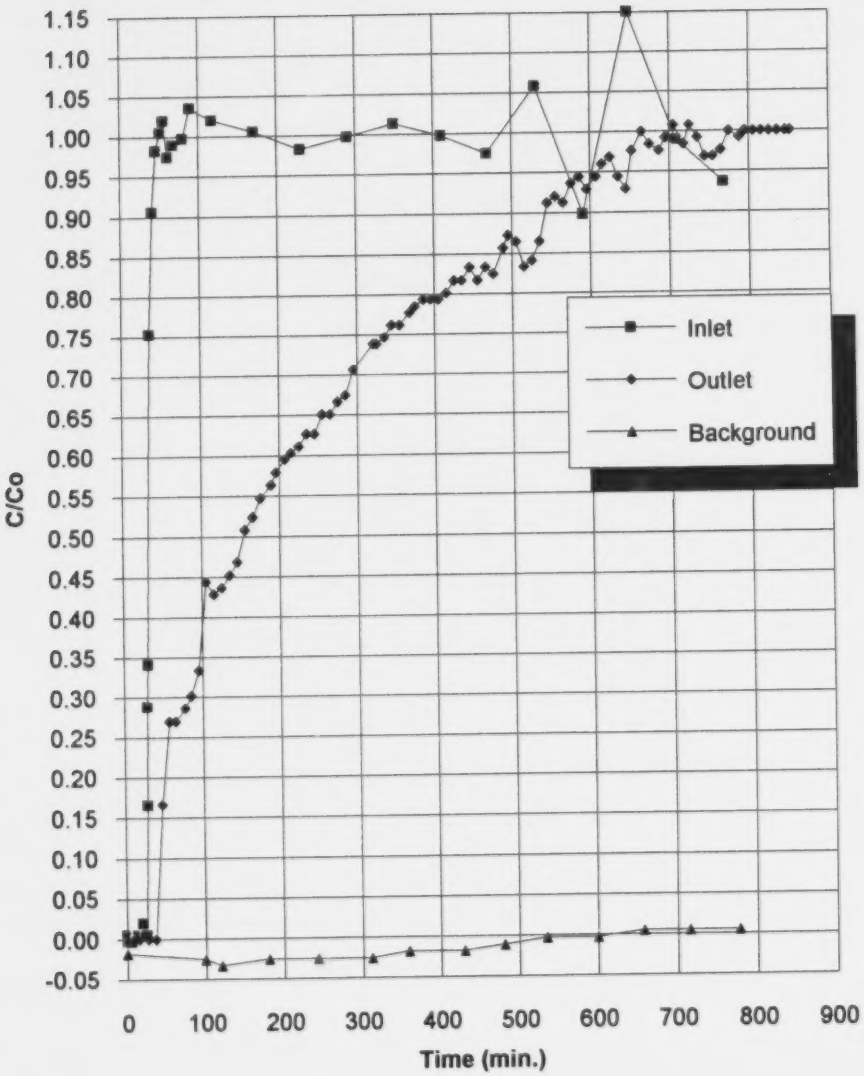


Figure 5.10: Test No.6 - Reservoir No. 2 at 141 ML/d

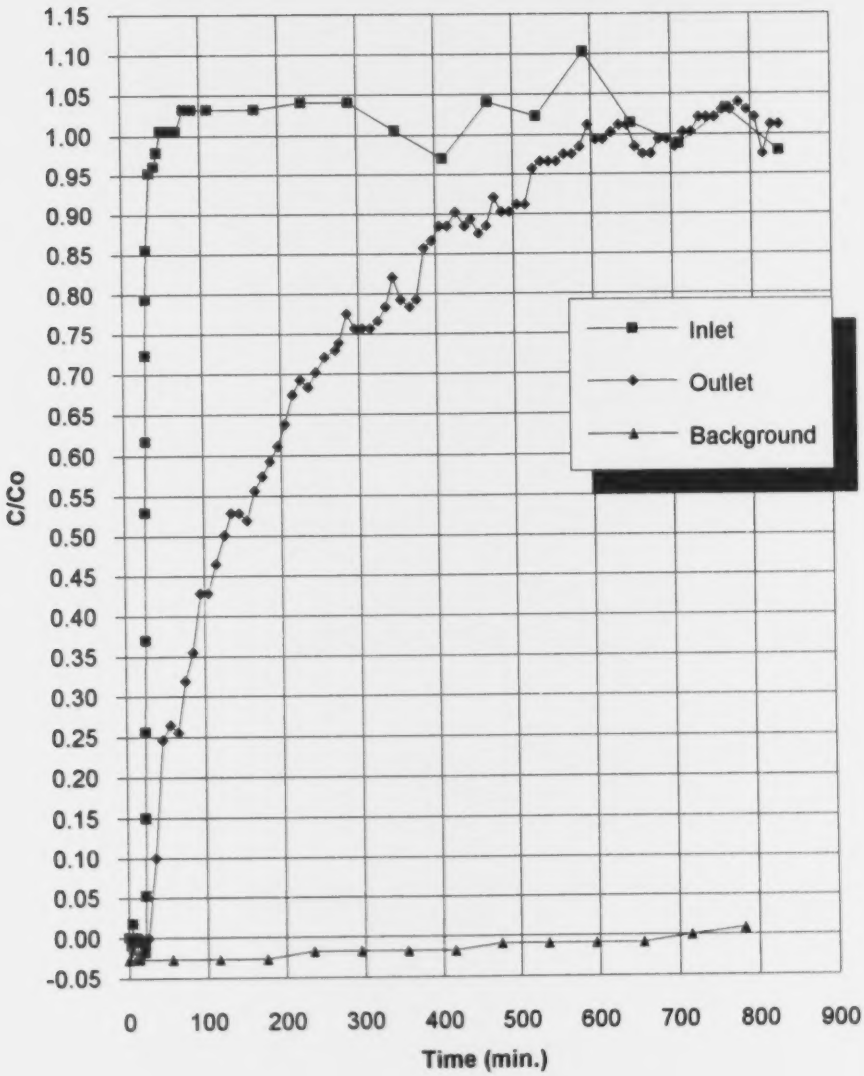


Figure 5.11: Test No.7 - Reservoir No. 3 at 179 ML/d

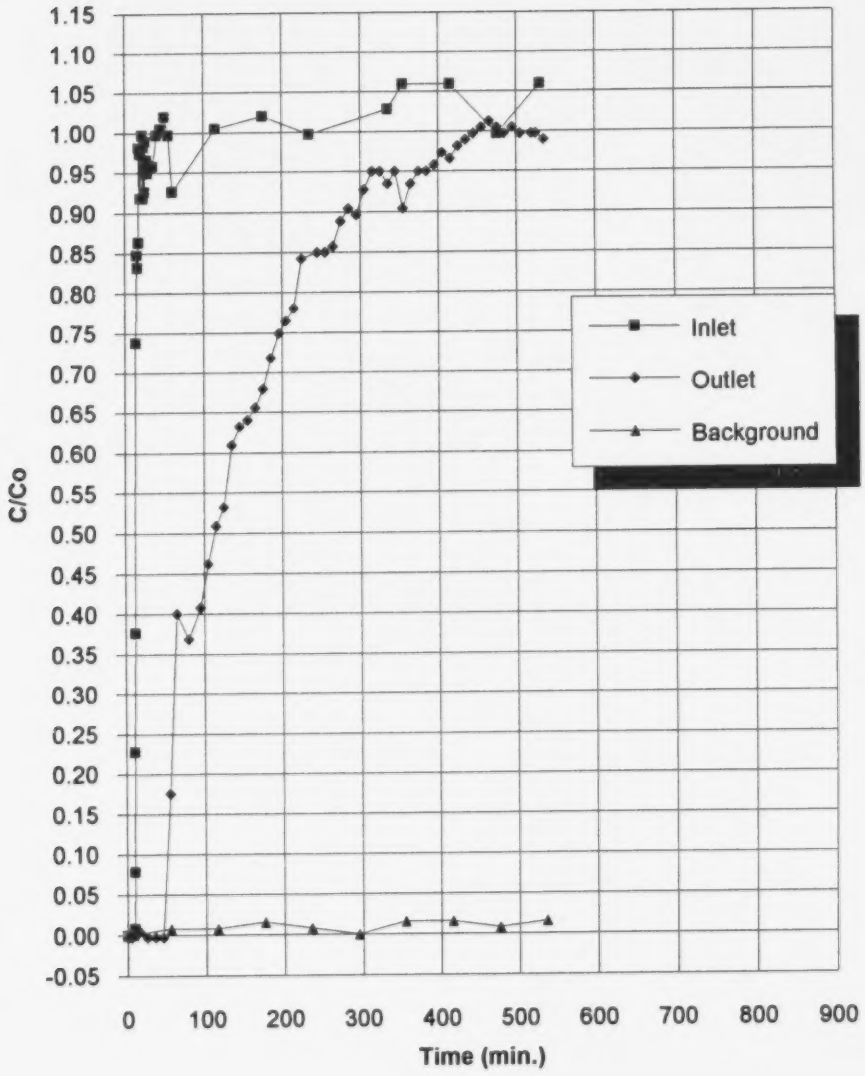


Figure 5.12: Test No.8 - Reservoir No. 1 at 230 ML/d

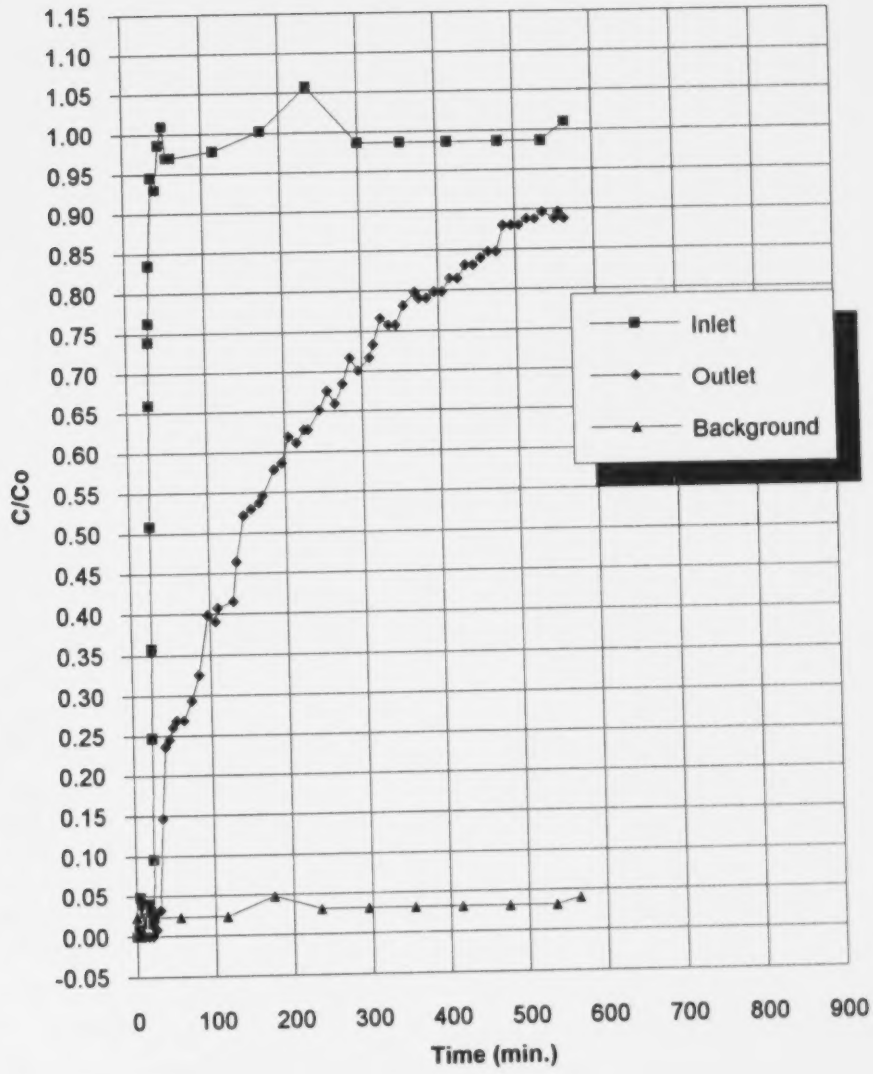


Figure 5.13: Test No.9 - Reservoir No. 3 at 198 ML/d

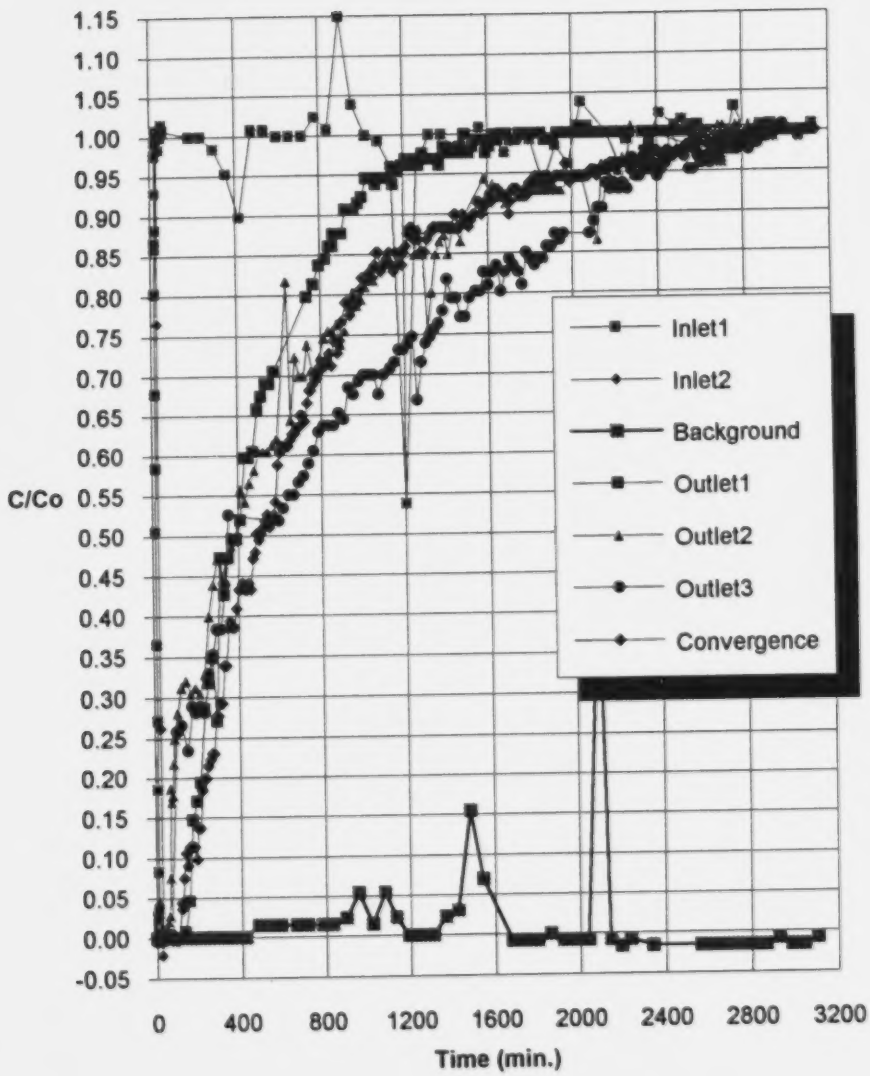


Figure 5.14: Test No.10 - Combined Reservoirs at 170 ML/d

The instrument reading error was found out by testing 30 times for each Na standard solution of 0, 5, 10, 15, and 20 mg/L. The average readings for the samples were 0.0, 33.1, 58.7, 81.0, and 99.0, respectively. While the standard deviations were found to be small: 0.00, 0.36, 0.36, 0.43, and 0.43, respectively. It is evident that the instrument error due to its floating can be neglected (see Appendix 6).

The tracer concentration was found easily by diluting the tracer samples for 1:10,000 in order to set the readings in the range of 0 to 100. The brine was found to be saturated and constant throughout the tests with the Na concentration equal to 131,000 mg/L.

Tracer recoveries are presented in Table 5.2. As indicated by the table, recoveries varied from 84% to 107%. The Guidance Manual (1989) recommends a recovery of at least 90%. Possible sources of errors in the recovery include: sodium analysis errors, loss of tracer to dead zones, inaccuracy in the plant flow rate and system volume, and errors in dose of tracer.

6.0 DISCUSSION

6.1 t_{10} and System Performance

Table 6.1 presents the tracer test results. Included in the table are the t_{10}, t_{90}, T_d, t_{10}/T_d, and t_{90}/t_{10}. From the table, it can be seen that the values of t_{10}/T_d vary from component to component. Time parameters t_{10} and t_{90} can be compared directly with the T_d. In most cases, this following condition must be fulfilled: $t_{10} \leq T_d \leq t_{90}$. The table shows that comparison among those three parameters is satisfied for all tests.

6.1.1 Filters and Clearwell Tests

As more than one inlet points were taken during filters and clearwell tests (tests nos. 1 and 2), the values of t_{10} and t_{90} were determined directly from the outlet points. As a result, the t_{10} and t_{90} values for those systems also include pipes and channels. Reasonable results were obtained from the tests, the decreased the flow the increased the values of t_{10} and t_{90}. The Guidance Manual (1989) considers filters as systems with a high percentage of uniform flow. It is possible to figure out the T_d based on the incoming flow and the effective water volume. In this case, there are two layers of filter media, 0.45 m of anthracite and 0.30 m of sand with porosity numbers of 0.58 and 0.44 respectively, yielding a total effective water volume for the six filters and the clearwell of 3642 m^3 (E. L. Smith Water Treatment Plant, 1993). Ratios of the t_{10} and T_d can be calculated (0.75 for 180 ML/d and 0.81 for 140 ML/d), that are categorized as "superior". Those values are very close to the value of 0.70 mentioned by the Guidance Manual (1989) for filter performance.

Table 6.1: Time Parameter Values

System	Flow (ML/d)	Water Volume (m^3)	t_{90} (min.)	t_{10} (min.)	T_d (min.)	$\frac{t10}{Td}$	$\frac{t90}{t10}$	Baffle Parameter
Filters + Clearwell	180	3642	91	22	29	0.76	4.1	superior
Filters + Clearwell	140	3642	100	30	37	0.81	3.3	superior
Clarifier No. 2	180	10700	125	25	86	0.29	5.0	poor
Reservoir No. 1	180	37140	494	79	297	0.27	6.3	poor
Reservoir No. 1	230	35120	265	41	220	0.19	6.5	poor
Reservoir No. 2	141	28570	503	16	292	0.05	31.4	nobaffle
Reservoir No. 2	167	32050	447	08	276	0.03	55.9	nobaffle
Reservoir No. 3	179	35178	394	12	283	0.04	32.8	nobaffle
Reservoir No. 3	198	43762	452	10	318	0.03	45.2	nobaffle
Reservoir No. 1,2,3	170	106640	1260	137	926[1]	0.15	9.2	poor
Reservoir Split: 20% Reservoir No.1	34	35120	-	-	-	-	-	-
38% Reservoir No.2	65	32050	-	-	-	-	-	-
42% Reservoir No.3	71	39470	-	-	-	-	-	-

1) Including 760 m pipe system with diameter = 2.1 m, assuming PFR.

6.1.2 Clarifier No. 2 Test

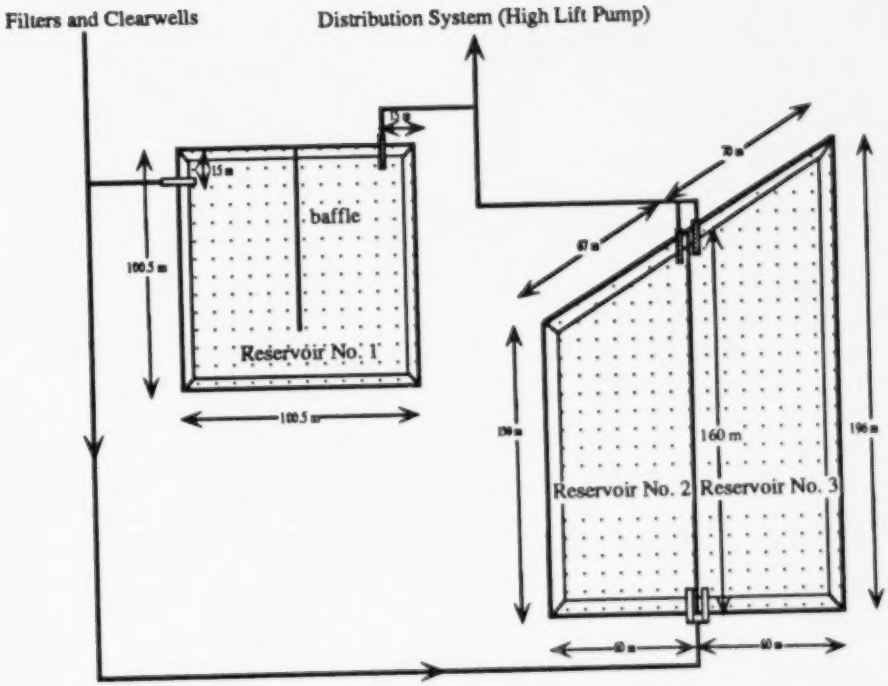
For clarifier no. 2 test (test no. 2), the outlet t_{10} and t_{90} are applied as the time parameters that include pipes and channels. Since there was only one test conducted for clarifier test, it is not possible to make any comparison for the t_{10} or t_{90}. The baffle parameter was found to be about 0.3 or classified as "poor".

6.1.3 Individual Reservoir Tests

In the case of individual reservoir tests (tests nos. 4 to 9), the individual value of t_{10} for each system can be calculated by taking the difference between the outlet t_{10} and the inlet t_{10}. Higher flow rates result in decreased values the t_{10} and t_{90} for each system with the exception of reservoir no.3 at 198 ML/d. The greater water level (water volume) in that system might have had a more dominant effect on the time parameters. The baffle parameters were found to be "poor" for reservoir no. 1 (t_{10}/T_d values range from about 0.2 to 0.3) and "no baffle" for the other two reservoirs (t_{10}/T_d values about 0.0). These values seem logical in consideration of the real physical condition of the reservoirs where one simple baffle was installed for reservoir no.1 and no baffle at all was constructed for reservoirs nos. 2 and 3. See Figure 6.1.

An interesting comparison can be made between the length to width (L/W) ratio vs. t_{10}/T_d results provided by the CH2MHILL (1993) (see Figure 6.2). The figure is based on numerous data collected from many systems. In the case of reservoir no. 1 with a L/W ratio of about 4, the t_{10}/T_d values should be in the range of 0.15 to 0.50 which are higher than the test results. For reservoirs no. 2 and 3 with L/W ratio values about 2.5 to 3, the t_{10}/T_d values given by Figure 6.2 should be in the range of 0.10 to 0.45 which are also greater than those of the real data. It is evident that those reservoirs have poor performance in consideration to the L/W ratio.

Several studies have been done to find out the correlation between the shape or



Note:

-slope inside reservoirs = 18°
8.5 m length x 2.75 width

-column diameter = 0.45 m
located every 5.4 m

-1.5 m diameter inlet pipe

-1.5 m diameter outlet pipe

-for reservoirs no. 2 and 3 all pipes are located at 1.5 m from the wall

Figure 6.1: Reservoirs Nos. 1, 2, and 3 Layout

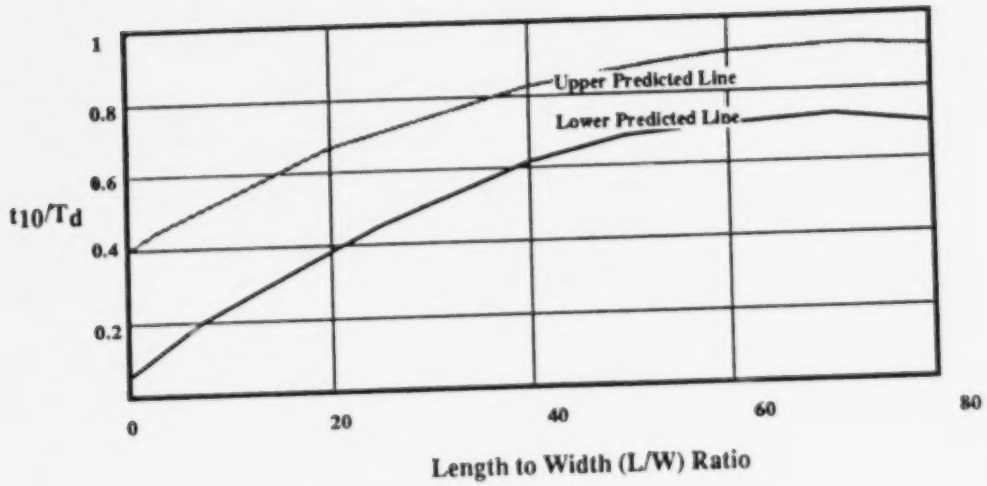


Figure 6.2: L/W Ratio vs. t_{10}/T_d (adapted from CH2MHILL, 1993)

geometric factor of the system and the degree of mixing. They show that an increase of L/W of the system results in a decrease of the mixing degree, but the correlation is poor. Other factors like depth to width ratio, outlet characteristics, turbulence, baffle conditions, and even wind also make differences. In general, a high length to width ratio system, with a depth to width ratio equals to 1 or less, plus one longitudinal baffle will be in a good resemblance with a PFR (Marske and Boyle, 1973). Two studies conducted by Kennedy et al (1991 and 1993) seemed to agree with those results. The first study found that a shallow system with a large surface area gave a nearly complete mixing. While the second study concluded that the system geometry has only little effect on the mixing behavior. The size of the system also makes a difference. The smaller the size, the more sensitive the dispersion number (Mitha and Mohsen, 1990).

Numerous tracer studies have set art to obtain values of t_{10}/T_d, such as Teefy and Singer (1990), Bishop et al (1990 and 1993), Dunn, et al (1991), Kennedy et al (1991), Process Development Team (1991), and Yu et al (1991). The Guidance Manual (1989) has also identified several types of systems to have some correlation with the baffle parameter. Rectangular and circular basins without baffle, with simple baffles, and complex baffles are interpreted as poor, average, and superior baffle conditions, respectively. Bishop et al (1991 and 1993) completed studies to verify those correlations using small pilot - scale circular and rectangular basins. While Hart (1975) used perforated baffles in order to avoid solid buildups in the corner areas. In general, all of those studies seem to agree each other. Still, more intensive hydraulic experiments beyond tracer studies are necessary to acquire such information about flow pattern in the system.

6.1.4 Combined Reservoir Test

The t_{10} and t_{90} obtained from the combined reservoirs in parallel test (test no.

10) were found directly from the outlet F curve, therefore they include all pipes and channels in the whole system. No comparison of the t_{10} and t_{90} values can be made for different flow rates, since there was only one test conducted. The baffle parameter was found to be "poor" with a t_{10}/T_d ratio of about 0.2.

The Process Development Team conducted a similar test for the combined reservoirs in parallel including filters. The total t_{10} was found to be 178 minutes at 160 ML/d, or about 148 minutes excluding the filters. While, the current study found the t_{10} equal to 137 minutes at 170 ML/d. Using Equation 4.1, the t_{10} for 160 ML/d can be predicted to be 146 minutes, with a difference of 6%. A complete investigation of all systems in the treatment plant using the CT concept will not be discussed as it has been done in the previous study (Process Development Team, 1991). After knowing the t_{10} for each system, the required CT value can be obtained from the standard CT tables. A more comprehensive discussion can be found in Andrews et al (1992).

Using the convergence point from test no. 10, it is possible to work out the flow split of the three reservoirs. Reservoirs nos. 1, 2, and 3 receive 20, 38, and 42% of the total flow, respectively (see Appendix 5). It is evident that reservoirs nos. 2 and 3 contribute the most impact on contact time in the disinfection process. Some modification, if any, should be prioritized for those two reservoirs.

6.2 Residence Time Distribution Analyses

The Morril's Index and baffle parameter, CMRs - in - series model, Wolf - Resnick model, Rebhun - Argaman model are the most common models used to analyze the residence time distribution performance. The dispersion model suggested by Thirumurthi and Levenspiel will not be covered as it deals with the E curve (the slug input). The jet model will be used to analyze reservoirs nos. 2 and 3, but not reservoir no. 1 due to its physical condition that makes it difficult to develop the model.

As has been mentioned above, the filters and clearwell, clarifier, and combined reservoirs are assumed as combined systems. The outlet F curves can be interpreted as the system residence time distribution. In the case of single reservoir tests, the residence time distribution curves can be worked out by taking difference of the outlet and inlet points (see Appendix 1). Summary of the results can be seen in Table 6.2.

6.2.1 Wolf - Resnick Model

This model in its simplified form (Equation 2.26) represents the entire residence time distribution. As a result, it gives a good estimation to the nature of the F curve. Parameter β indicates the time shift of the curve, while parameter α gives an estimation to the curve slope / skewness.

Interesting results can be seen in Table 6.2. From a comparison between tests on the two filters and the clearwell, it can be seen that for the low flow test (test no. 2 at 140 ML/d), it seems that the flow behaves more like a PFR than that for the high flow (test no. 1 at 180 ML/d). Note: in the case of PFR, parameter α should equal to 1, while parameter β should be $+\infty$ to form a vertical line right on $t/T_d = 1$. A reasonable explanation can be drawn that there is a smaller momentum effect in the system and the flow is distributed evenly over the filter media. This can be seen from parameters α and β; the lower the flow the bigger the β (intercept with x axis) and the bigger the α (slope) as well. For clarifier and combined reservoir tests, no comparison can be made since only one type of flow test was undertaken for each system.

Some interesting results were obtained from single reservoir tests (tests nos. 4 to 9). Generally, the higher the flow, the lower the β, and the higher the α, with the exception of reservoir no.3. It can be explained by assuming that inside the reservoirs momentum effects are dominant. The higher the flow, the less the β as the water travels faster and appears earlier at the outlet point, hence the lower the time delay. The faster

Table 6.2: Residence Time Distribution Analyses

		FILTERS+C.WELL		CLARIFIER NO.2	RESERVOIR NO. 1		RESERVOIR NO. 2		RESERVOIR NO. 3		COMBINED RESERVOIRS
Data											
Flow	(ML/d)	180	140	180	180	230	141	167	179	198	170
Water Level	(m)	-	-	-	4.1	3.9	3.6	4.0	3.6	4.4	-
Volume	(m^3)	3642	3642	10700	37140	35120	28570	32050	35178	43762	109271
Td	(min.)	29	37	86	297	220	292	276	283	318	926
Direct Measurement											
t10	(min.)	22	30	25	79	41	16	8	12	10	137
t90	(min.)	91	100	125	494	265	503	447	394	452	1260
Morril's Index: t90/t10		4.1	3.3	5.0	6.3	6.5	31.4	55.9	32.8	45.2	9.2
Baffle Parameter: t10/Td		0.76	0.80	0.29	0.27	0.19	0.05	0.03	0.04	0.03	0.15
Baffle Description		superior	superior	poor	poor	poor	no baffle	no baffle	no baffle	no baffle	poor
Wolf - Resnick Model: C/Co = 1-Exp		**(−α*(T−β))**									
α		1.19	1.81	1.61	1.87	2.22	1.54	1.59	1.68	1.62	1.60
β		0.62	0.73	0.22	0.22	0.16	0.04	0.02	0.01	0.01	0.11
Rebhun - Argaman Model: ln(1-C/Co) = -[1/(1-p)(1-d)] t/Td + p/(1-p)											
p (degree of PFR)	(%)	41.2	58.9	26.5	27.4	25.9	4.5	2.4	2.1	3.7	13.8
d (dead space)	(%)	-50.5	-23.8	18.7	19.3	36.7	21.2	25.6	33.3	29.0	27.7
t10	(min.)	20	28	24	83	46	32	23	20	22	139
CMRs in Series											
N		25	37	3	3	3	1	1	1	1	2
Jet Model											
l (length of travel)	(m)	-	-	-	-	-	145	145	175	175	-
do(imaginary diameter)	(m)	-	-	-	-	-	1.0	1.1	0.7	1.2	-
t10	(min.)	-	-	-	-	-	13	12	10	14	-
Morril's Index		-	-	-	-	-	38.7	37.3	39.4	32.3	-
Baffle Parameter: t10/Td		-	-	-	-	-	0.045	0.043	0.035	0.044	-
Baffle Description		-	-	-	-	-	no baffle	no baffle	no baffle	no baffle	-
Uo	(m/min.)	-	-	-	-	-	124.73	122.10	323.17	122.25	-
C1 (simplified form: t10=l^2/Uo do C1)		-	-	-	-	-	13.0	13.0	13.5	14.9	-

the water travels, the steeper the slope, and the bigger the α. For reservoir no. 3 at 198 ML/d parameter β equals to that at 179 ML/d, but parameter α is smaller. This aberration can be explained by considering the difference of the water levels for these two tests. As reservoir no.3 at 198 ML/d has a higher water level than that at 179 ML/d (4.4 m vs. 3.6 m), it is logical to make a conclusion that the increase in water level (water volume) is more dominant than the increase of flow that gives rise to the decrease of α.

Other interesting points are shown in Figures 6.6 to 6.11 for single reservoir tests. It is clear that the Wolf - Resnick model does not fit the curves obtained from the tracer studies, especially for the early points which are important in determining the value of t_{10} in the CT concept. The most logical explanation is that this model is basically derived from mass balance of the system. It also appears that the model fits reservoir no.1, especially at a low flow rate, better than reservoirs nos. 2 and 3. Reservoir no.1 has only one simple baffle while reservoirs nos. 2 and 3 do not have baffles at all, the momentum / jet effect seems to be more dominant in the latter reservoirs as the water flows almost directly from the inlet to the outlet, so that the early real points from the tests come faster than those from the model.

In the case of filters + clearwell and clarifier tests (Figures 6.3 to 6.5), the model seems to match the whole curve. The same result also occurs for the combined reservoir test (Figure 6.12). This means that basically the momentum effect does not dominate these systems. The fluid does not travel directly from the inlet to the outlet point due to physical conditions in the case of filter and clarifier tests, and due to the low flow (split flow) for the combined reservoir test.

Still, although this model does not fit the real data well, it is still valid to compare the general pattern of one curve with another. For example, if the first curve is steeper (having a bigger α) than the second curve but has the same time shift (the

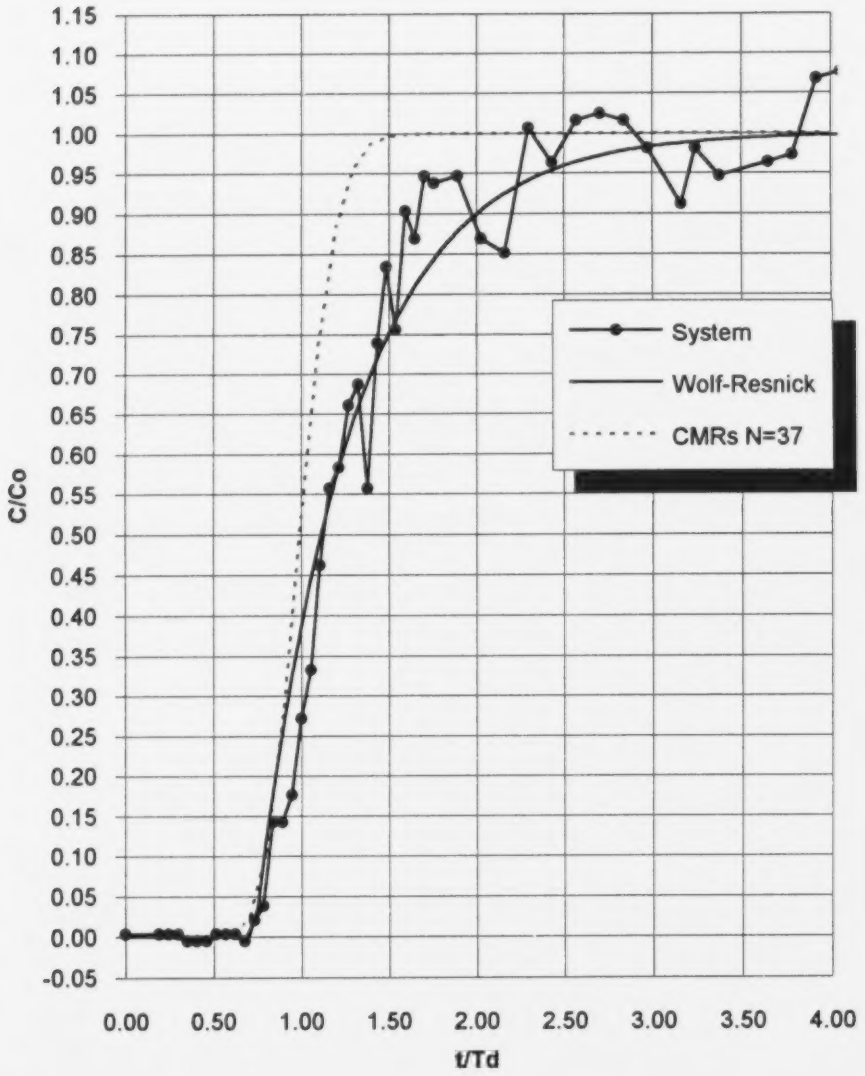


Figure 6.3: Filters + Clearwell at 140 ML/d for Wolf-Resnick and CMRs - in - Series Models

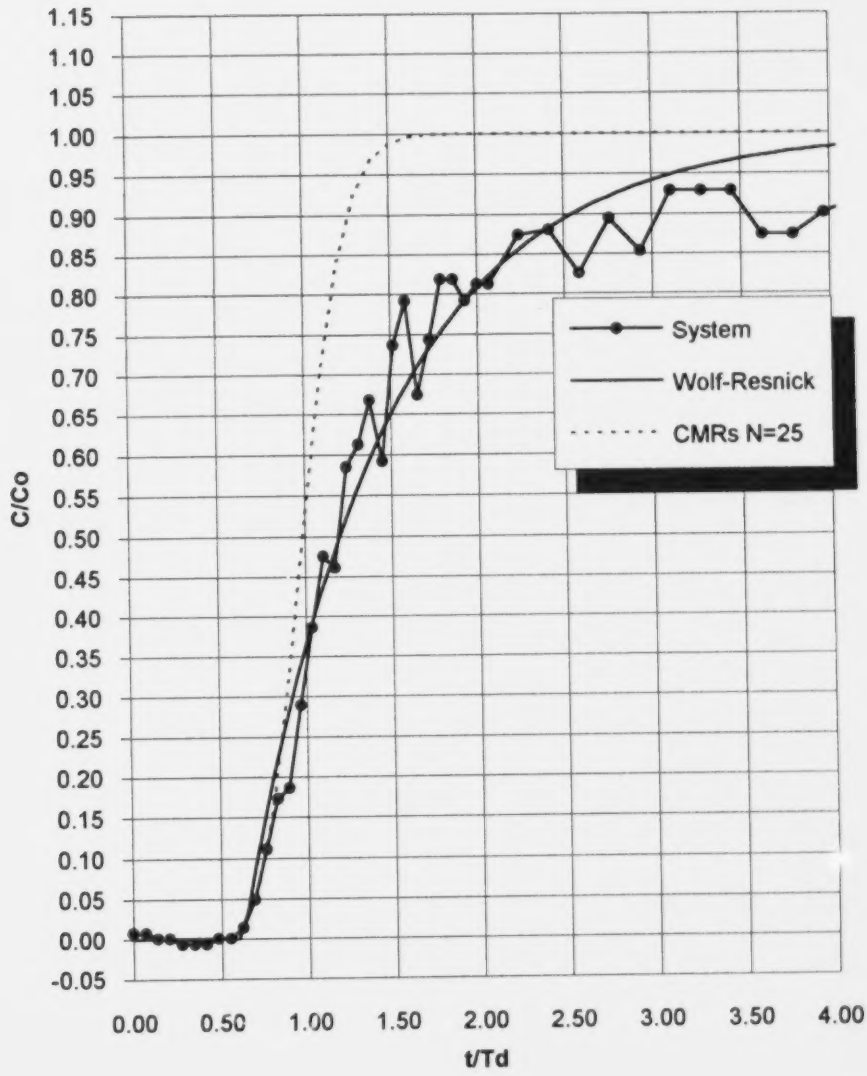


Figure 6.4: Filters + Clearwell at 180 ML/d for Wolf-Resnick and CMRs - in - Series Models

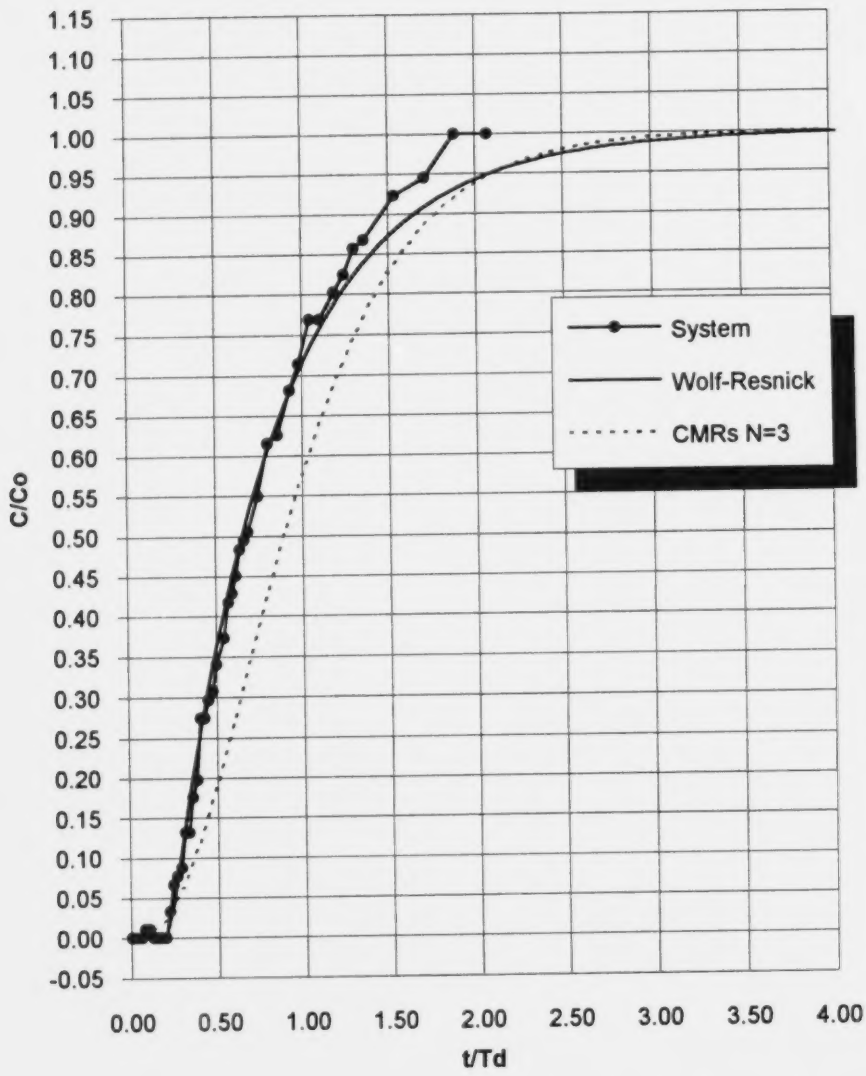


Figure 6.5: Clarifier No.2 at 180 ML/d for Wolf-Resnick and CMRs - in - Series Models

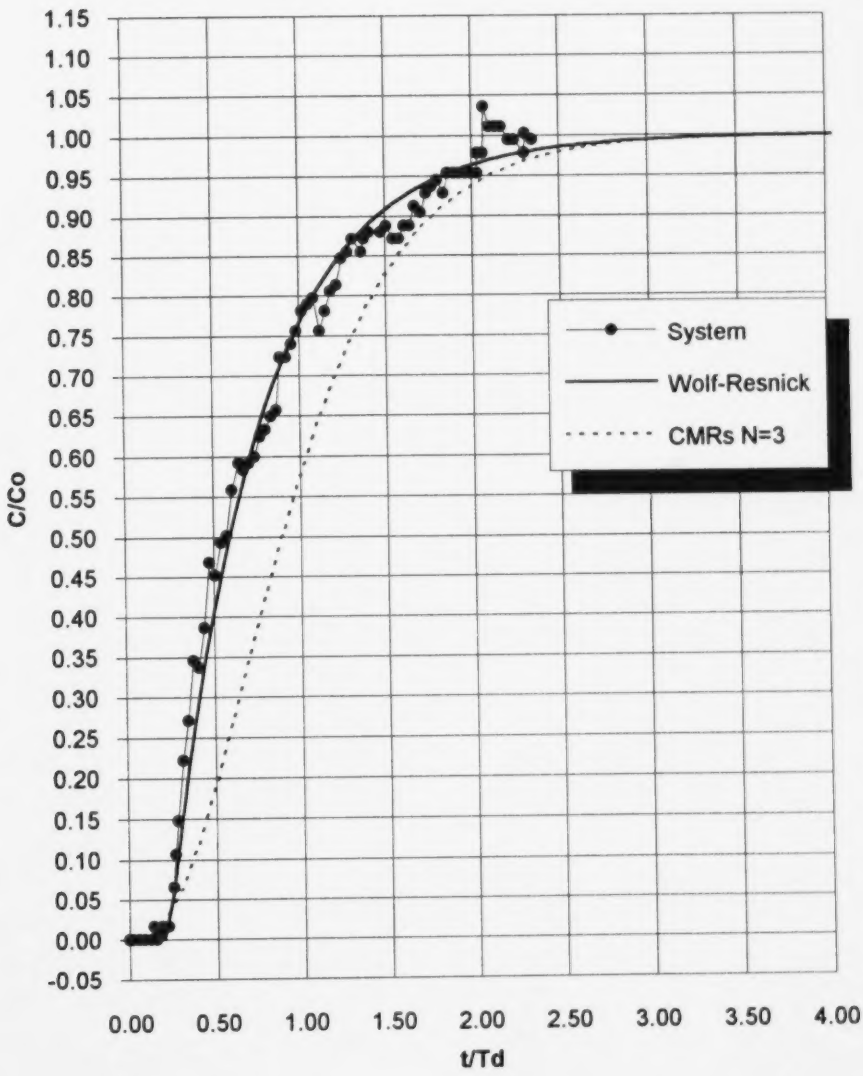


Figure 6.6: Reservoir No.1 at 180 ML/d for Wolf-Resnick and CMRs - in - Series Models

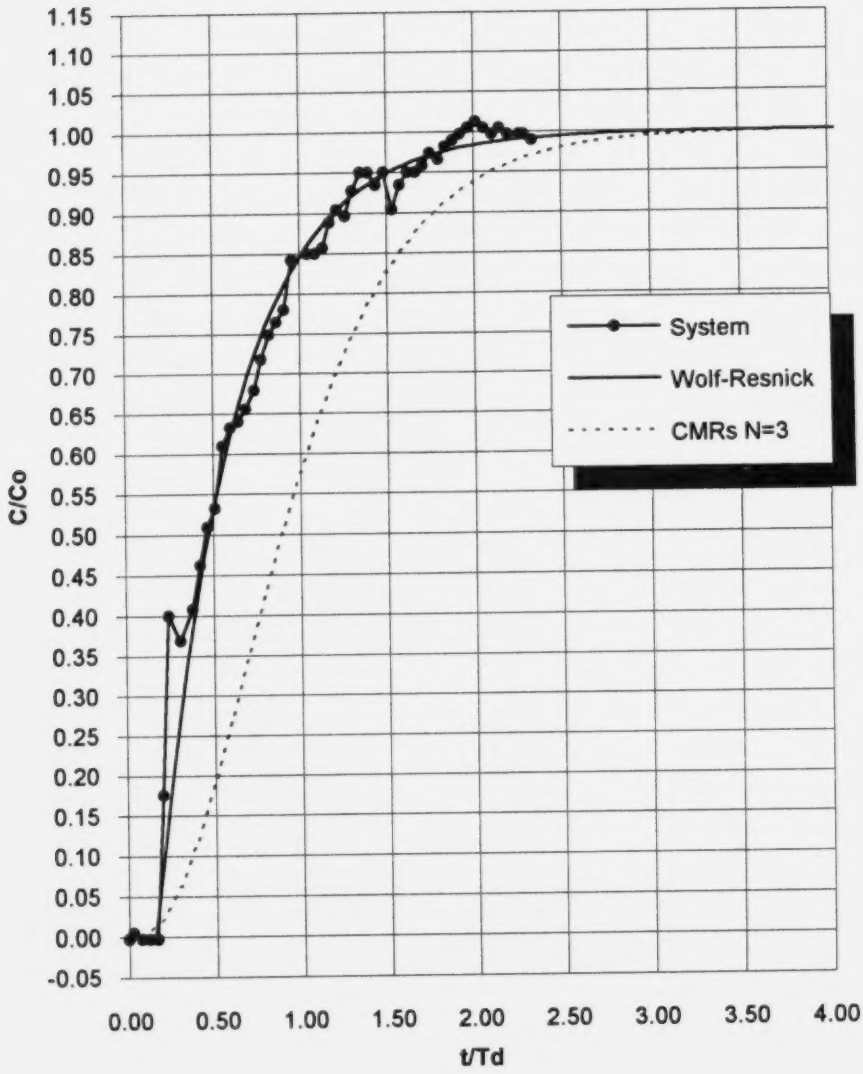


Figure 6.7: Reservoir No.1 at 230 ML/d for Wolf-Resnick and CMRs - in - Series Models

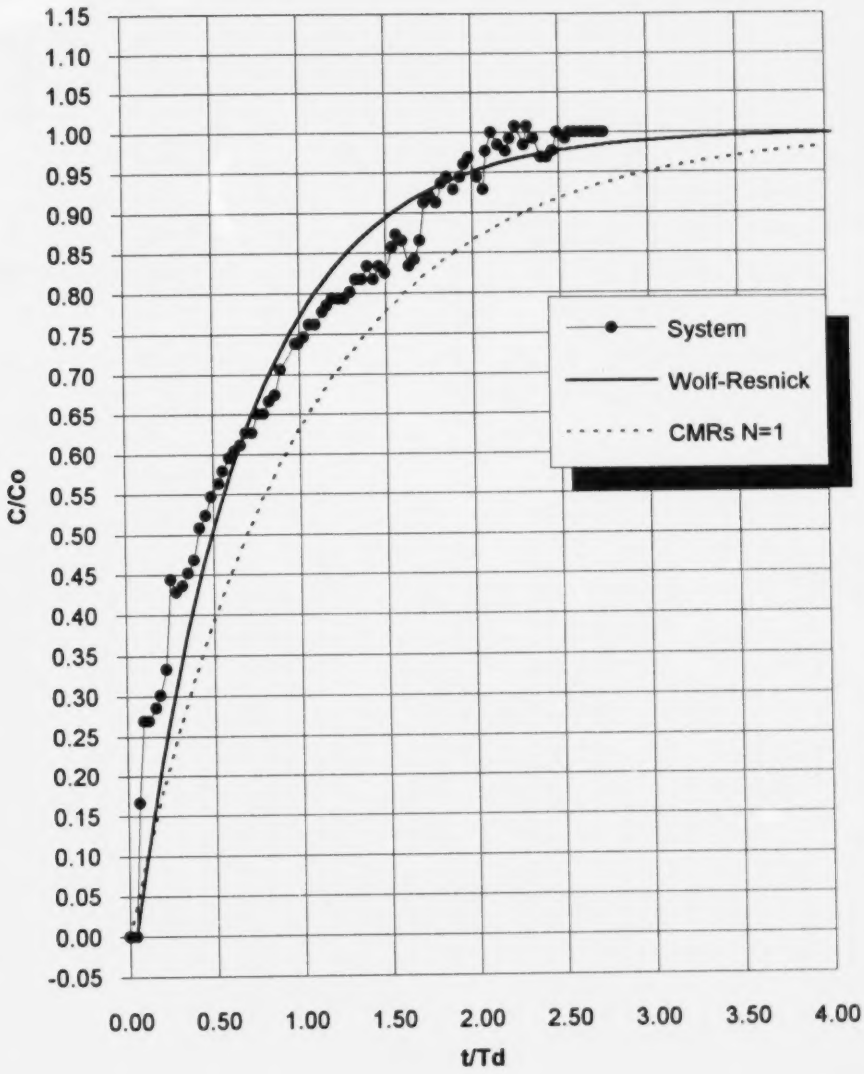


Figure 6.8: Reservoir No.2 at 141 ML/d for Wolf-Resnick and CMRs - in - Series Models

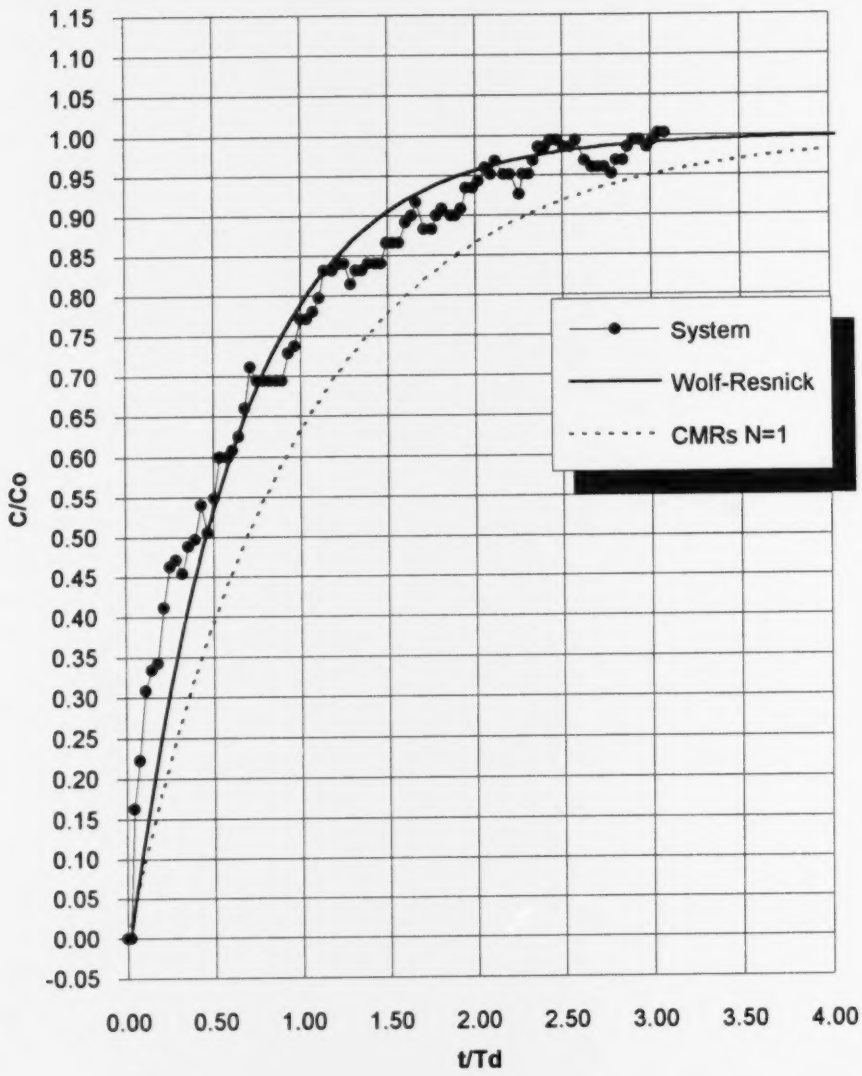


Figure 6.9: Reservoir No.2 at 167 ML/d for Wolf-Resnick and CMRs - in - Series Models

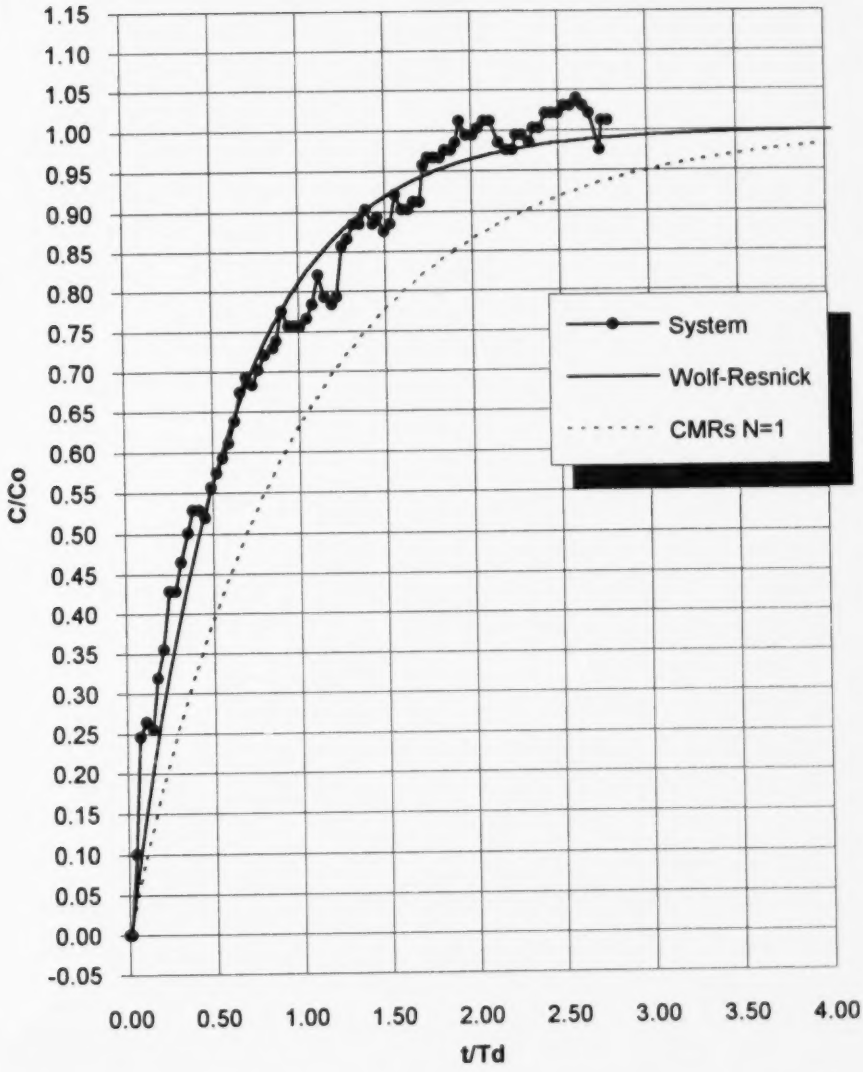


Figure 6.10: Reservoir No.3 at 179 ML/d for Wolf-Resnick and CMRs - in - Series Models

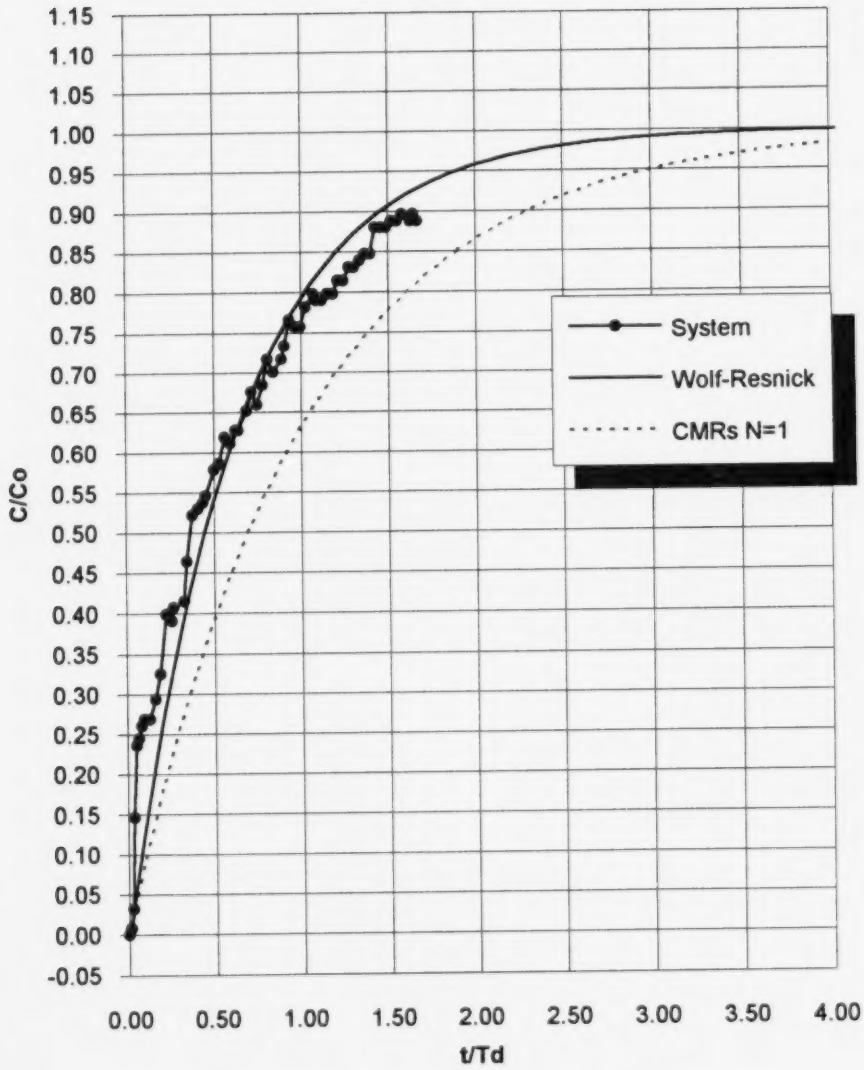


Figure 6.11: Reservoir No.3 at 198 ML/d for Wolf-Resnick and CMRs - in - Series Models

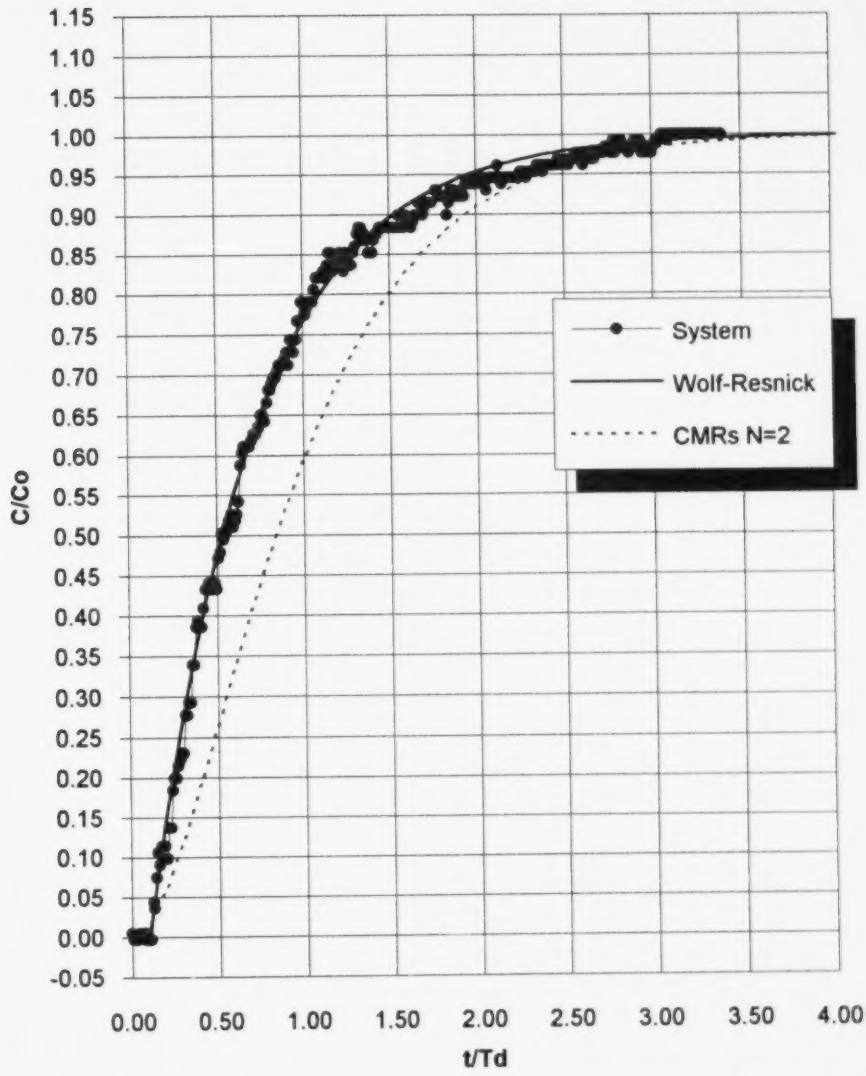


Figure 6.12: Combined Reservoirs at 170 ML/d for Wolf-Resnick and CMRs - in - Series Models

same β), the t_{10} for the first curve must be less than the second one.

6.2.2 CMRs - in - Series Model

This model does not fit the observed data. Again, the greatest difference occurs in the early stage of the curves. The jet effects are dominant in the case of single reservoir tests which are not represented by the model. Figures 6.3 to 6.12 show that after trying several values of N, there is no one that fits the data well.

6.2.3 Rebhun - Argaman Model

This model basically linearizes the Wolf - Resnick equation using a log or ln scale for the horizontal axis. Parameter p indicates the degree of PFR; the higher the p, the bigger the time shift and the steeper the line. Parameter d represents the dead space fraction; the bigger the d, the steeper the line but does not affect the time shift.

Because of a high level of noise in the filters and clearwell data, reliability of the results is questionable (see Figures 6.13 to 6.14). As shown in Table 6.2 above, the dead space fraction should not be less than 0%. In the case of clarifier and combined reservoir tests, the model fits the observed data very well (see Figure 6.15 and 6.22). Once again, no comparison can be made to assess the effect of the flow rate as only one flow rate test conducted for each system.

Interesting results were found in the case of single reservoir tests (tests nos. 4 to 9). Considering data obtained from the tracer studies, it seems that higher flow rates will give rise to a decrease in the p (degree of PFR) and an increase in the d (degree of dead space). But, as can be seen in Table 6.1, the exception occurs again for reservoir no. 3. The same argument can be used: the increase of the reservoir water level (volume) is more dominant than the increase of the flow that affects the t_{10} for reservoir

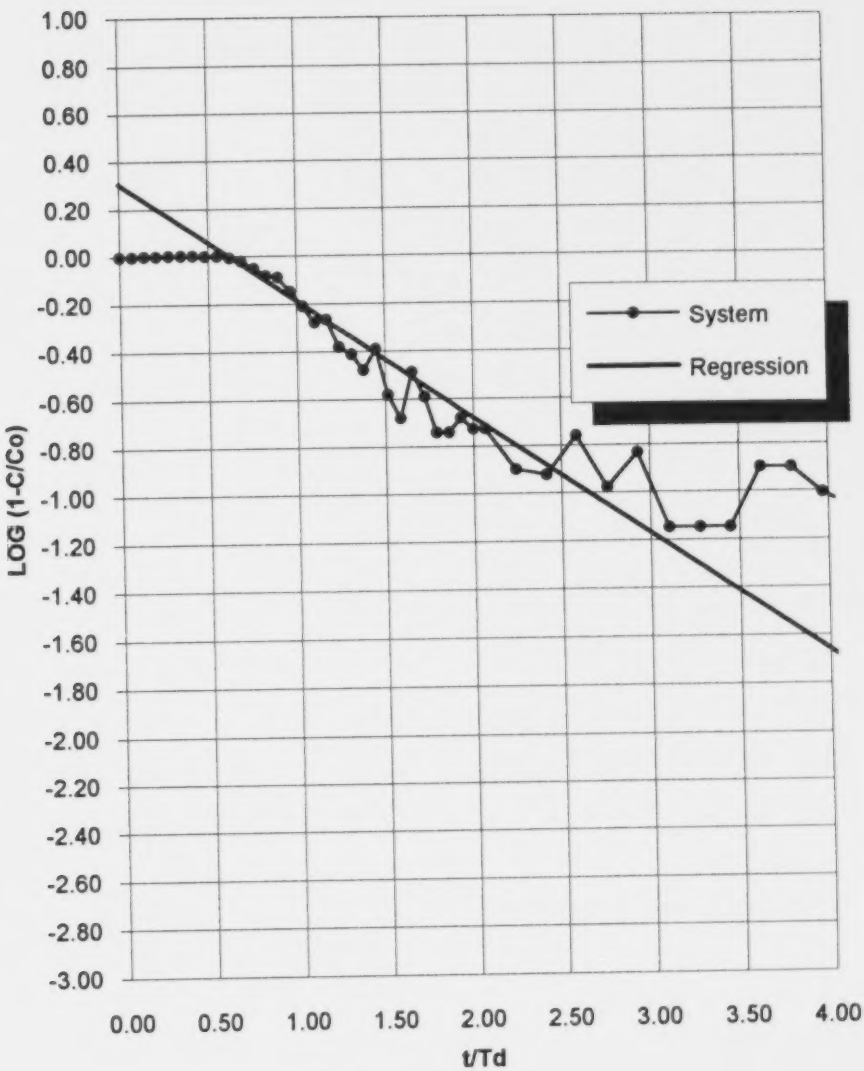


Figure 6.13: Filters + Clearwell at 140 ML/d for Rebhun-Argaman Model

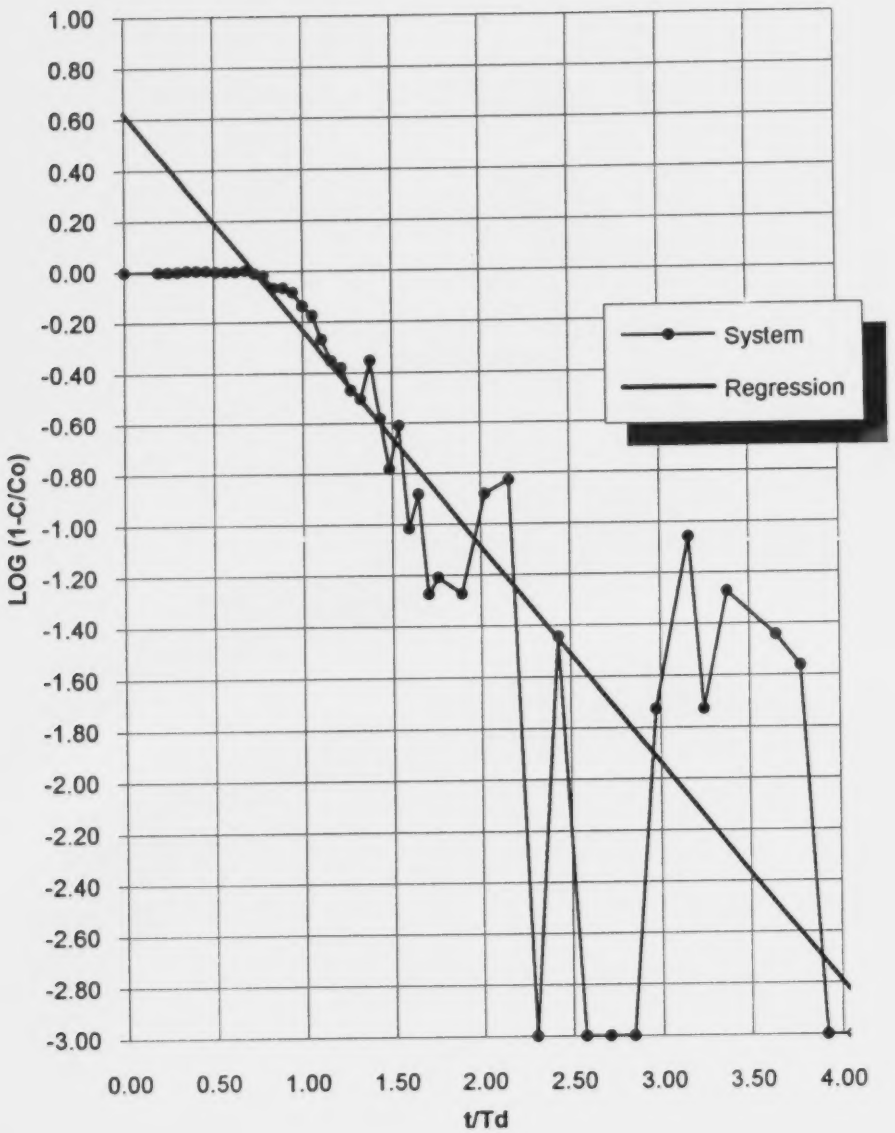


Figure 6.14: Filters + Clearwell at 180 ML/d for Rebhun-Argaman Model

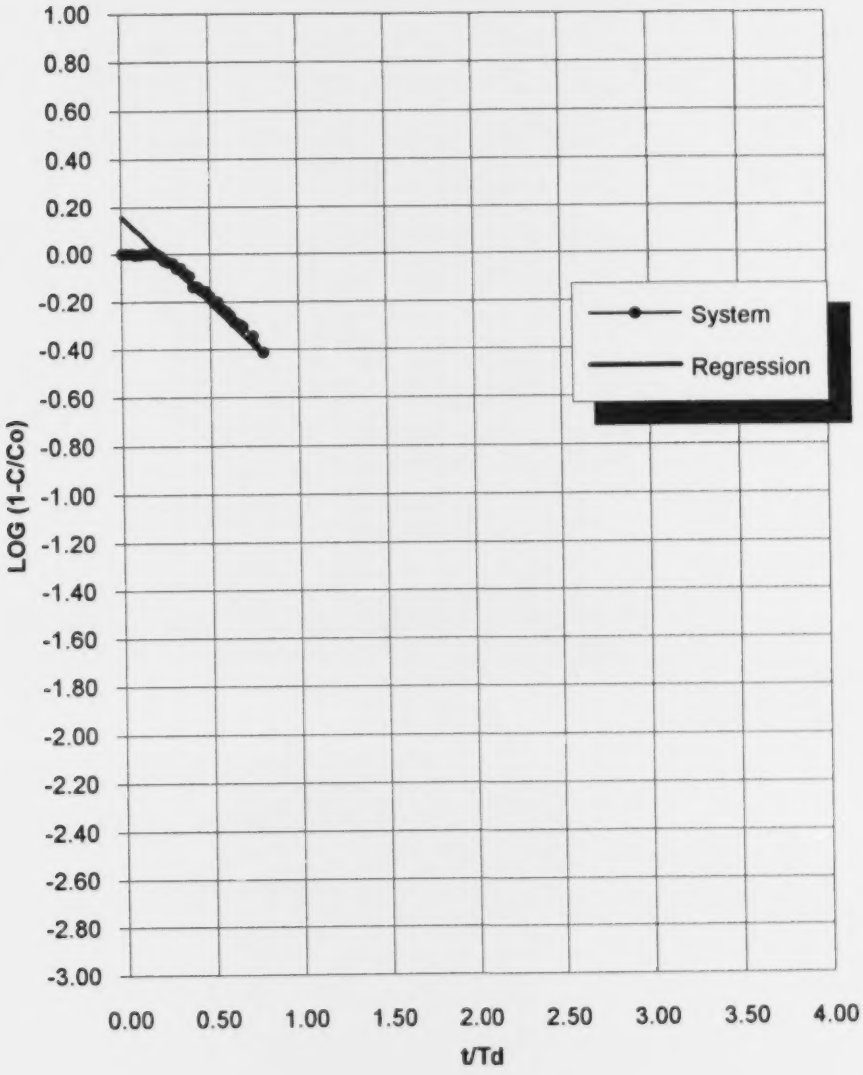


Figure 6.15: Clarifier No.2 at 180 ML/d for Rebhun - Argaman Model

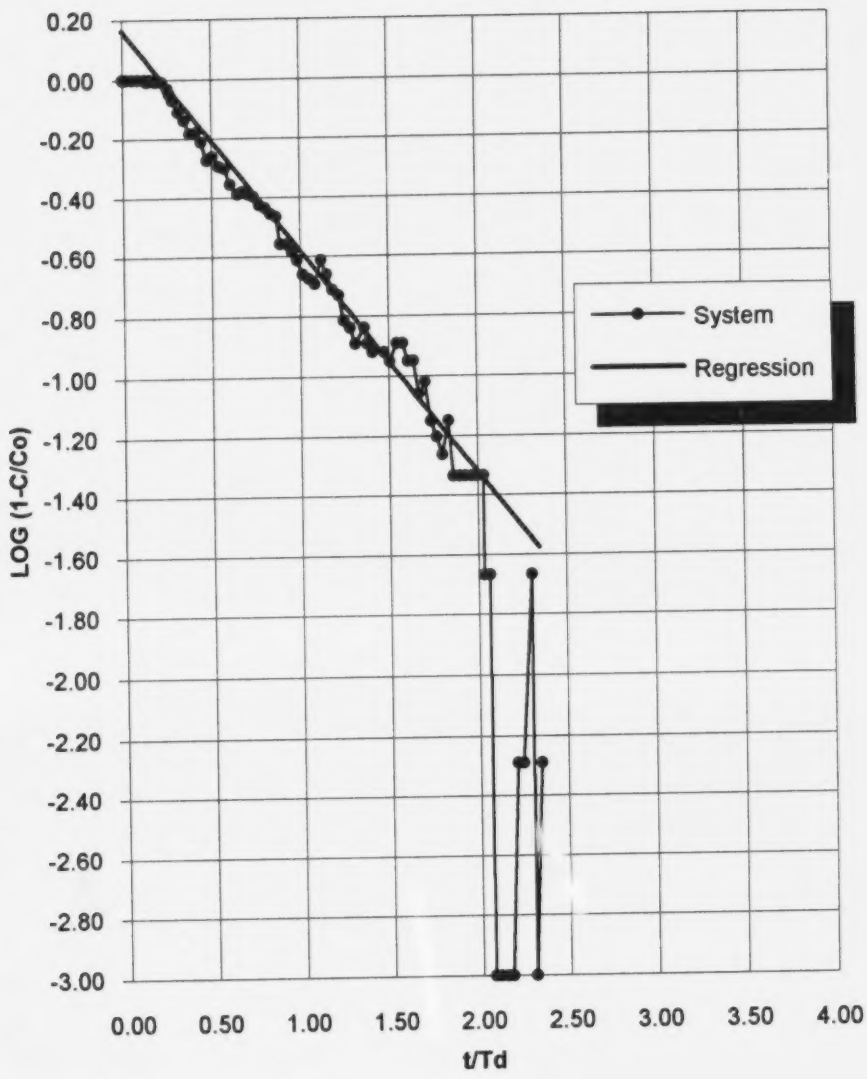


Figure 6.16: Reservoir No.1 at 180 ML/d for Rebhun-Argaman Model

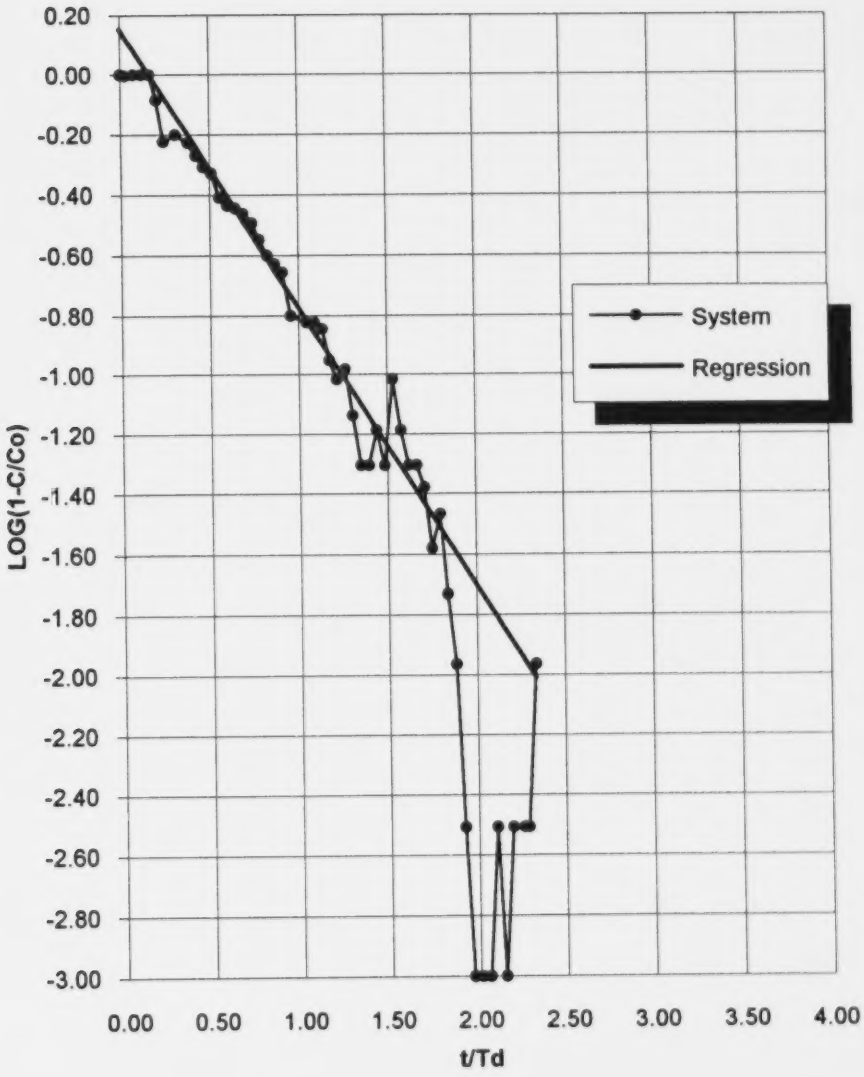


Figure 6.17: Reservoir No.1 at 230 ML/d for Rebhun-Argaman Model

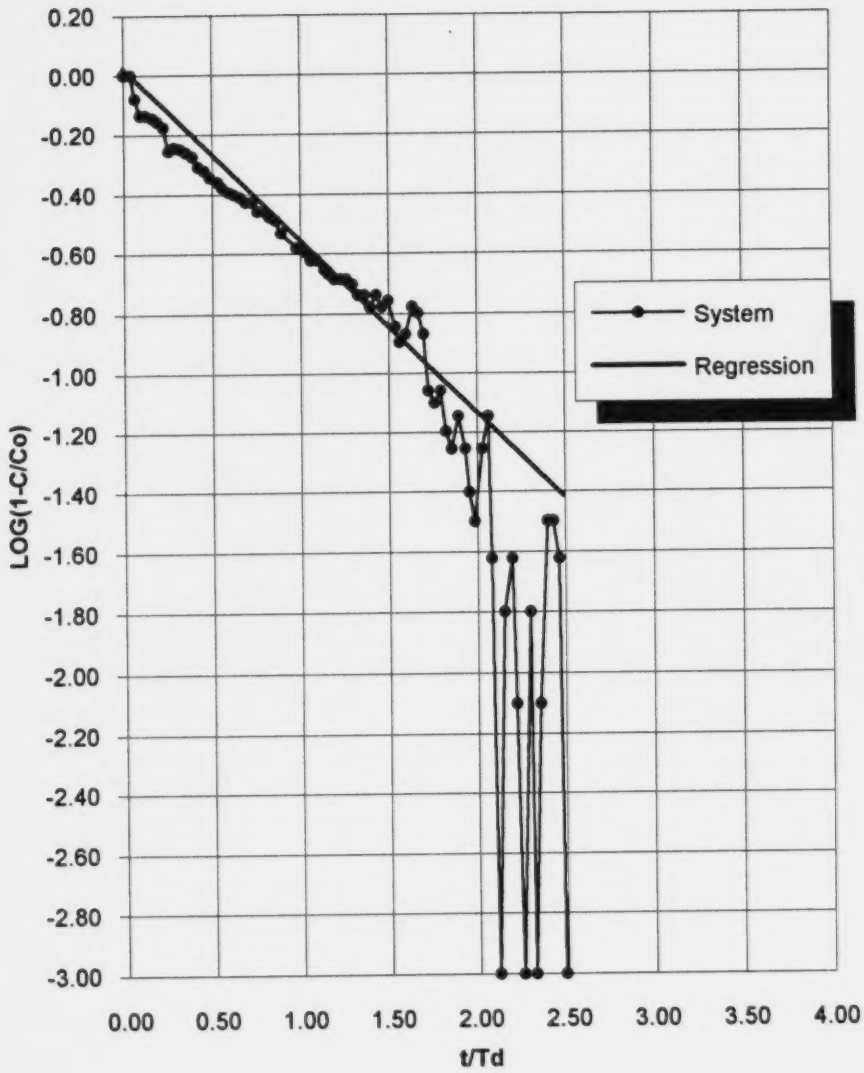


Figure 6.18: Reservoir No.2 at 141 ML/d for Rebhun-Argaman Model

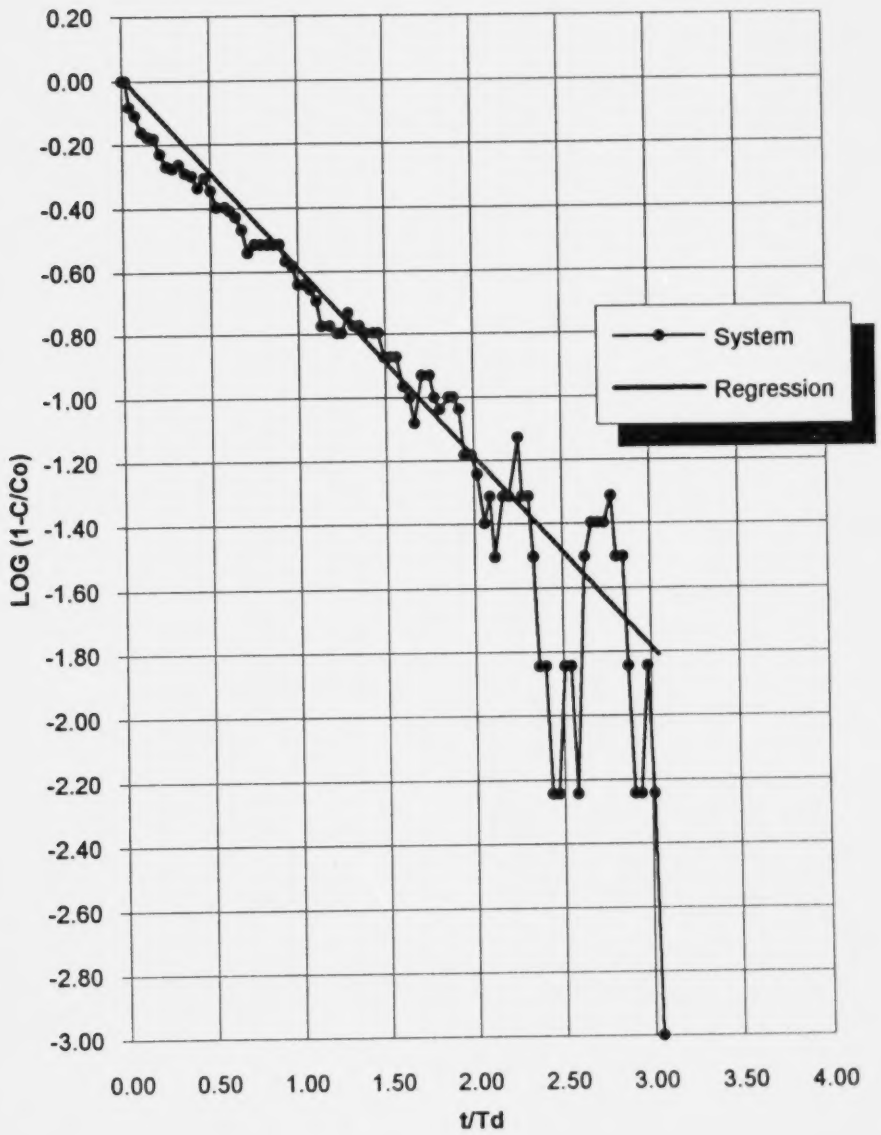


Figure 6.19: Reservoir No.2 at 167 ML/d for Rebhun-Argaman Model

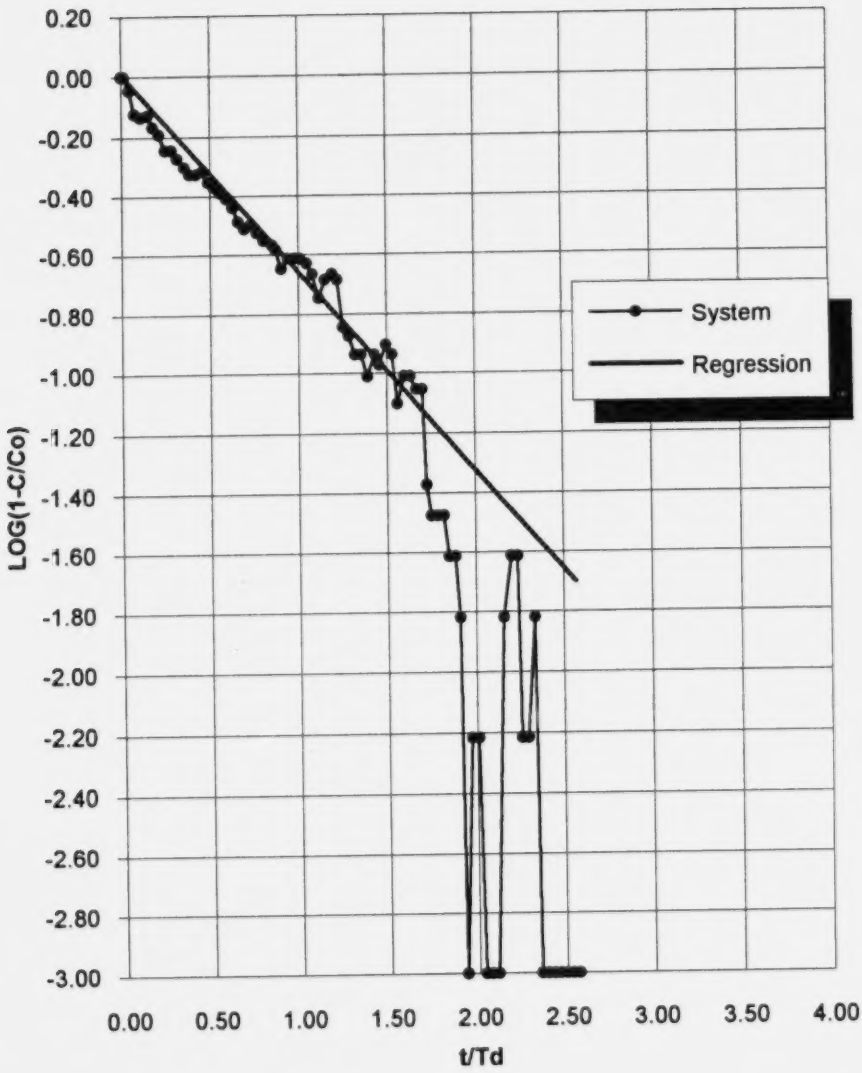


Figure 6.20: Reservoir No.3 at 179 ML/d for Rebhun-Argaman Model

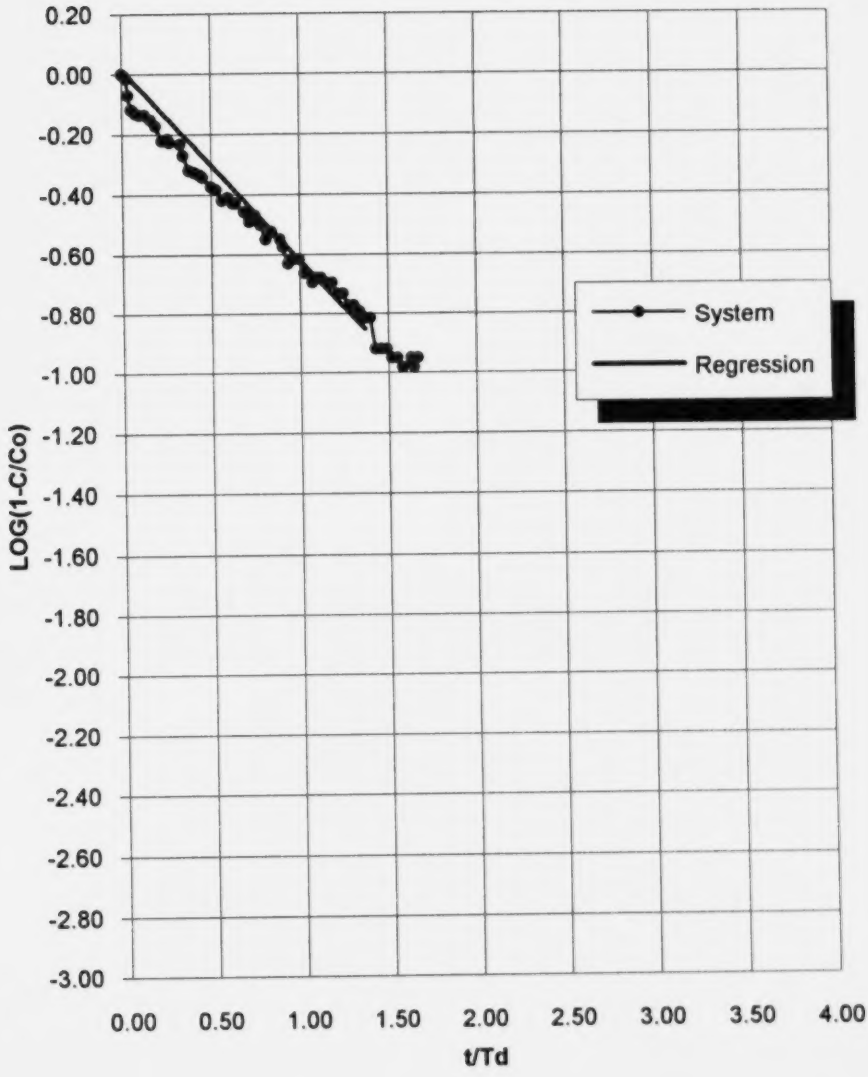


Figure 6.21: Reservoir No.3 at 198 ML/d for Rebhun-Argaman Model

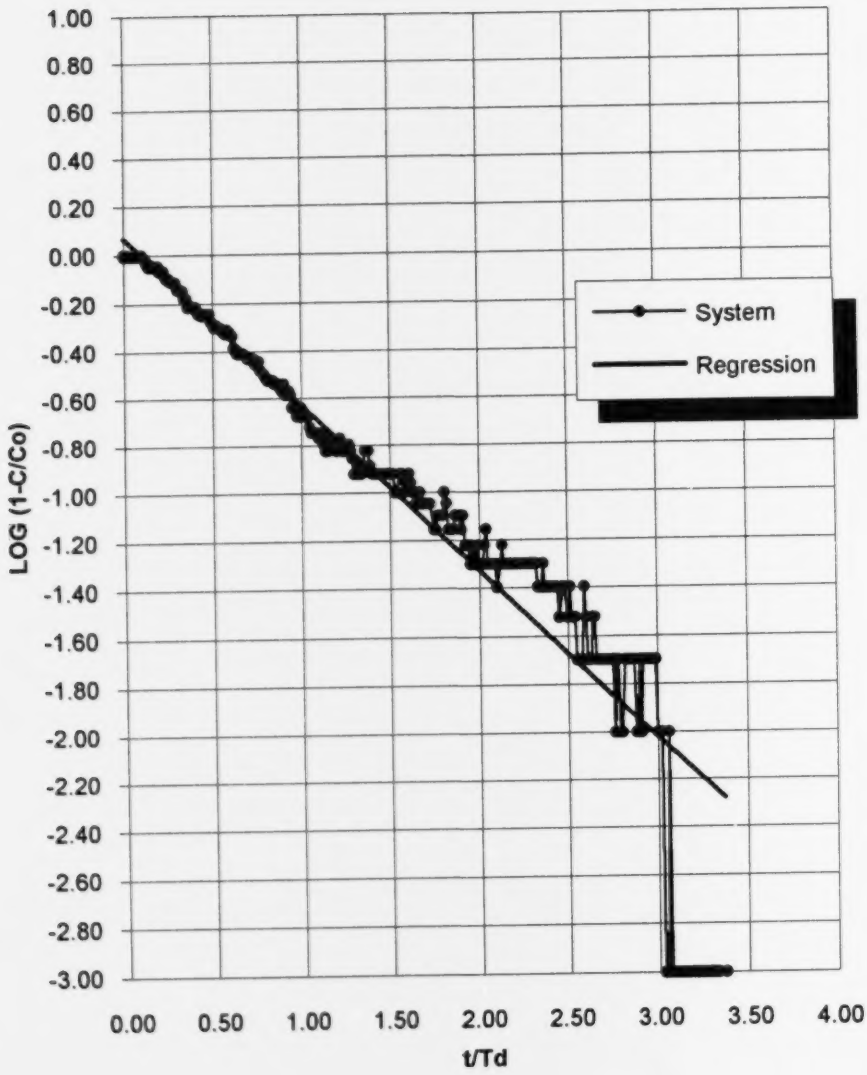


Figure 6.22: Combined Reservoirs at 170 ML/d for Rebhun-Argaman Model

no. 3. See Figures 6.16 to 6.21 above.

The same problem occurs for the early points of the curves for single reservoir tests (tests nos. 4 to 9) but not for the other tests (tests nos. 1, 2, 3, and 10). The same explanation can be given, momentum effects seem dominant for single reservoir tests. Table 6.2 shows that using this model to predict the t_{10} values for reservoirs nos. 2 and 3 can result an over prediction in the order of about 50%. While, in the case of other systems without the momentum effect, prediction using this model seems very good with the maximum difference of about 5% only.

6.2.4 Morril's Index and Baffle Parameter.

The main weakness of the Morril's index (t_{90}/t_{10}) is that it basically depends only on discrete points in the F curve rather than considering the whole residence time distribution. It also does not give a direct qualitative assessment to the SWTR / CT concept. The baffle parameter (t_{10}/T_d) suggested by the Guidance Manual (1989) has the same problem, notwithstanding the fact that it is the only parameter that gives a direct qualitative assessment of a system relative to the SWTR / CT concept. The Morril's index has a slight advantage over the baffle parameter, because the two time parameters (t_{10} and t_{90}) can be found directly from the F curve. In the case of the baffle parameter, T_d needs to be calculated. This means field data such as incoming flow and system volume must be to obtained.

Table 6.2 shows that in the case of filters + clearwell tests and reservoir no. 1 test, both parameters do not seem to be affected by the change of flow rates. In general, the Morril's index tends to increase with the flow, while the baffle parameter does the opposite. The change for the Morril's index due to the flow rate seems to be greater than that for the baffle parameter. From this point of view, the baffle parameter is considered to be better than the Morril's index as it appears to be more constant for different flow

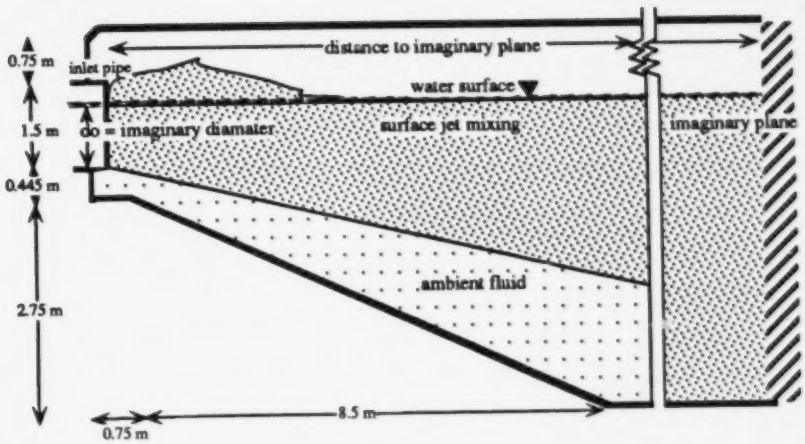
rate changes.

6.2.5 Jet Model

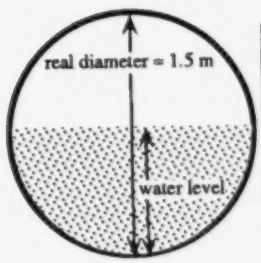
As indicated in the previous section, the empirical models do not tend to fit the observed data well for reservoirs nos. 2 and 3. The poorest fit is in the initial portions of the curve which is important in determining the t_{10}. As these reservoirs have unbaffled inlets and the results indicate that the tracer appeared at the outlet much sooner than expected, it is hypothesized that momentum from the inlet may be responsible for this phenomena.

Flow through the reservoir then was modelled as if there was a jet from the inlet. If velocity and concentration values based on the jet hydraulics tended to match the observed tracer results, it would indicate that the hypothesis could be correct. However, if the jet model indicated that the tracer should arrive much sooner or later than what was observed, doubt would be cast on the hypothesis. Further investigation would be required to determine why the tracer traveled so fast through the reservoir.

The model is based on the standard jet equations that have been explained in chapter 2. A half circular - shape of jet is used which is divided into layers from 0° to 10° from the center line with increments of 1°. Since reservoirs nos. 2 and 3 have the shape of trapezoid, it is assumed that the imaginary planes lie in the middle distances of the diagonal parts, or in the distances of 145 and 175 m, respectively (see Figure 6.23). Each flux that hits the plane is assumed to be removed directly to the outlet point. As the jet model is generated from the inlet profile, it is logical to choose the height of water in each reservoir by taking an average of the water level data for the first hour only, as the inlet profiles reach the steady state before 1 hour (see Figure 6.23). The imaginary diameter can be developed, then the initial velocity of the jet (U_o) can be worked out. The total flux for each layer can be obtained by multiplying the chemical



Note: imaginary plane for Reservoir no. 2 = 145 m
imaginary plane for Reservoir no. 3 = 175 m



Reservoir No.	Flow (ML/d)	Water Level (m)	Length of Travel (m)	Real do (m)	Imaginary do (m)	Uo (m/min)
2	141	3.9	145	1.5	1.0	124.7
2	167	4.0	145	1.5	1.1	122.1
3	179	3.6	175	1.5	0.7	323.2
3	198	4.2	175	1.5	1.2	122.3

Figure 6.23: Surface Turbulent Jet Profile

concentration by the velocity. The C/C_o values for each system can be found by dividing the total flux by the incoming flow as has been explained in the previous chapter. The detail calculation can be found in Appendix 4.

It was found that all of the C/C_o values almost reached 1 (about 0.98), representing the total recovery of the tracer. Different calculation was done assuming that only the core of the jet contributed the most flux of the jet. Note: the jet core means the portion of the jet that does not come into contact with the bottom. It has a radius equal to the reservoir depth at the outlet end of the reservoir. It was assumed that the core had an angle of 2° from the center line. Similar calculation was completed considering only up to 2° degree layers that gave a value of C/C_o of about 0.15 (see Appendix 4).

Figures 6.24 to 6.27 show that the curves obtained from the jet model fit with the real data up to about $C/C_o = 0.20$ only. This is as expected as the core of the jet has a total tracer (C/C_o) of about 0.15. As the t_{10} lies on the area where the jet model fits to the observed data, it is possible to predict the t_{10} using this model. The estimation is considered to be good (see Table 6.2).

In order to verify the turbulent assumption of the jet, the lowest Reynold number can be obtained for reservoir no. 2 at 141 ML/d. The Reynold number was found to be 1.6×10^6, or much greater than 3,000 for the turbulent flow criterion (Blevins, 1984).

6.2.6 Simplified Jet Model

This model is a development of the previous model. Using Equation 2.92, it is interesting to notice that the constant C_1 seems to be constant in the range of 13.0 and 14. 9 (determined experimentally) or which it should be if the jet effect is dominant (see Table 6.2). This model can be used as a base to determine the t_{10} at other flow rates.

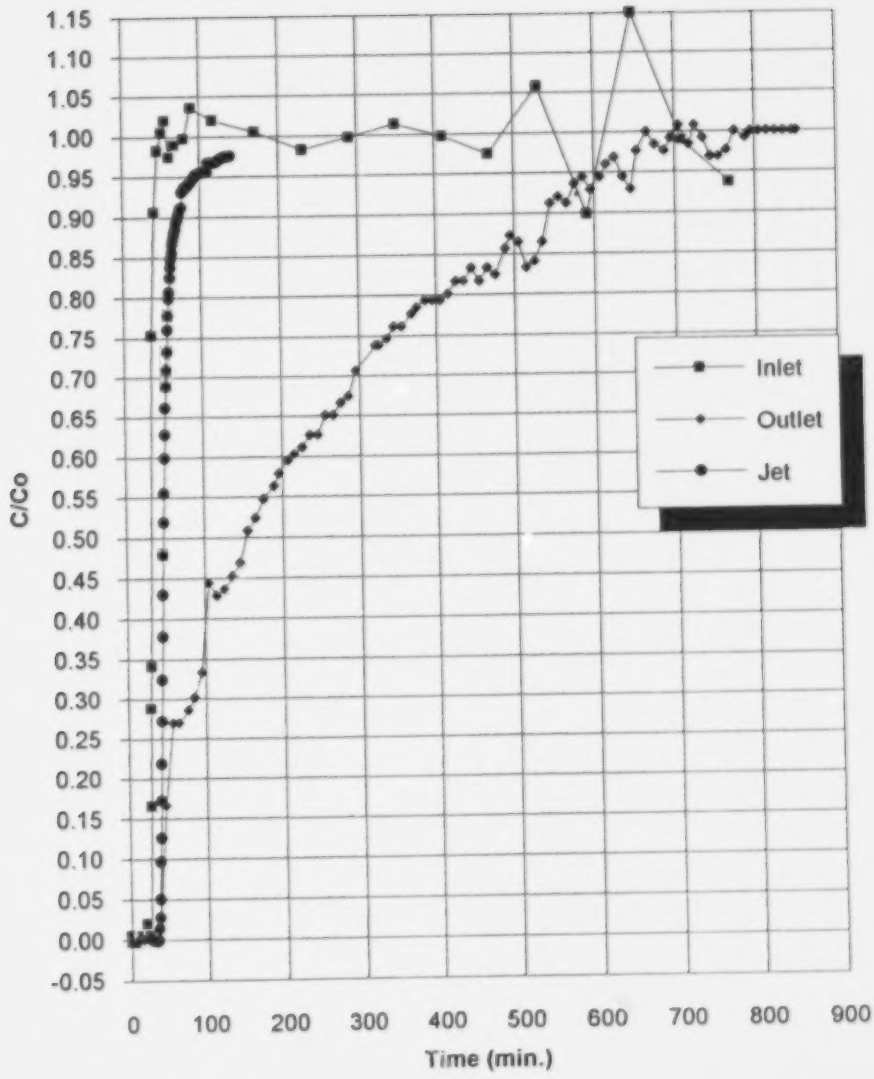


Figure 6.24 Reservoir No. 2 at 141 ML/d for Jet Model

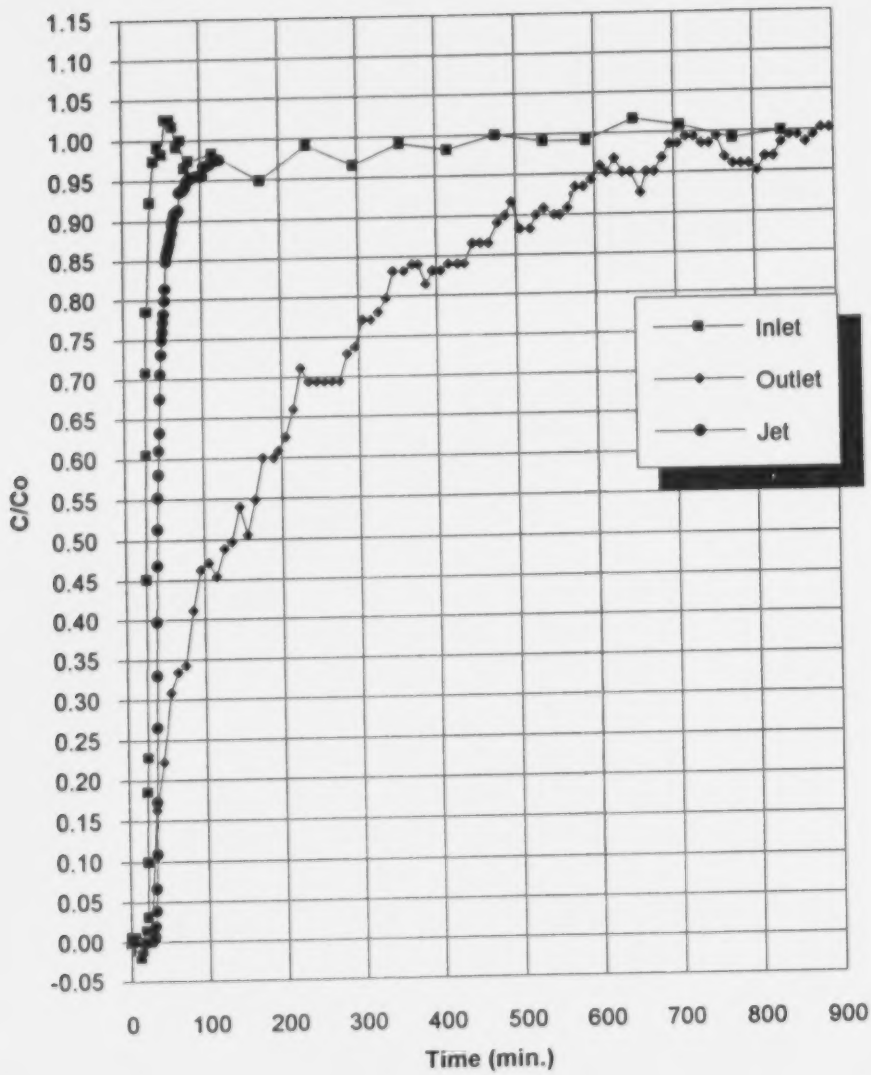


Figure 6.25 Reservoir No. 2 at 167 ML/d for Jet Model

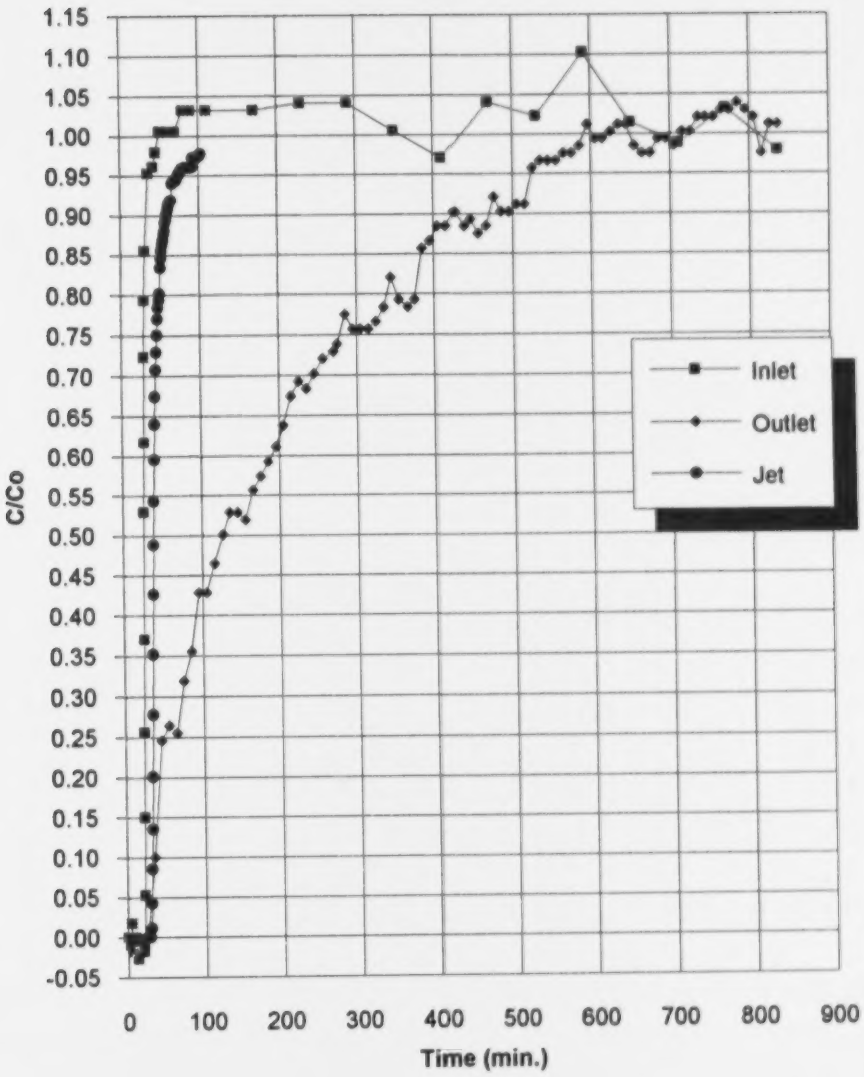


Figure 6.26: Reservoir No. 3 at 179 ML/d for Jet Model

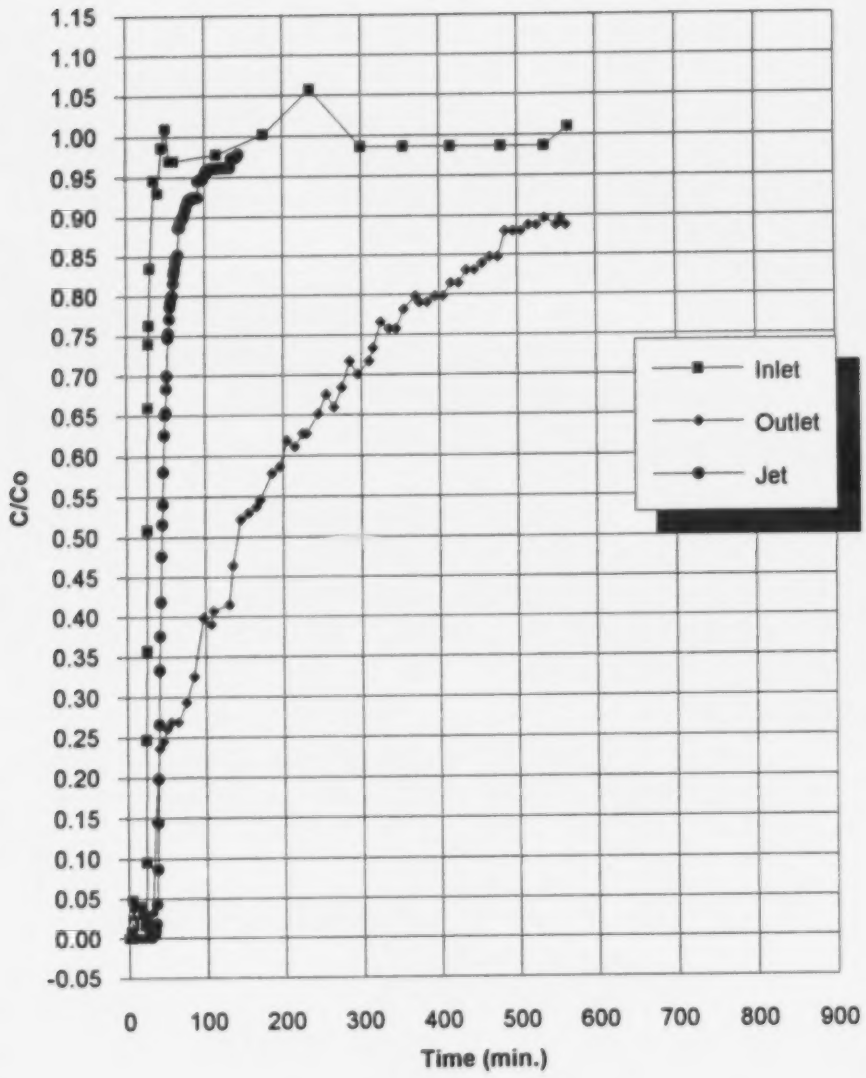


Figure 6.27: Reservoir No. 3 at 198 ML/d for Jet Model

6.3 Suggestions for System Modification

The modeling seems to indicate that jet effect is dominant in the case of reservoirs nos. 2 and 3. t_{10} can be increased by decreasing or eliminating the jet effect. The first alternative is to construct baffles inside the reservoir. Reservoir no. 1 has a baffle that reduces the jet effect. It can be seen from the parameters t_{10}/T_d that are greater compared with those for reservoirs nos. 2 and 3.

Another option is to install diffusers in the inlet. The idea is to spread the momentum across the whole width of the reservoir. In addition, momentum from a jet will dominate the flow for approximately 100 diameters of the jet out from the discharge point. By diffusing the water with many small jets, the momentum dominated distance is greatly reduced. Using a well designed diffuser should result in flow that closely resembles a PFR plus dispersion. Interesting results were recently obtained in another study by the University of Alberta (University of Alberta, 1994). Tracer studies were conducted at the Rossdale Water Treatment Plant in Edmonton, Alberta. Two of the tests were conducted at two identical rectangular stilling basins (6700 L each). The inlet has many weirs to distribute the flow evenly across the inlet of the basin. There was no jet effect found in this case, the t_{10} values are quite large (73 minutes for 55 ML/d and 58 minutes for 75 ML/d), and the output profiles are very close to the PFR with small dispersion.

In the case of filters + clearwell, no modification is required since the system is classified as "superior" already. Clarifier no.2 and reservoir no.1 with the baffle parameters of about 0.3 may also need some modification.

7.0 CONCLUSIONS

The first three conclusions given are related to the general test results for the case study (E. L. Smith Water Treatment Plant performance). While, the second five conclusions relate generally to the residence time distribution in water treatment plants. Three last comments are related to the SWTR / CT concept (1989).

1). The t_{10} values obtained from the tests can be applied to investigate the system compliance to the CT concept. According to the baffle parameter suggested by the Guidance Manual (1989), the mixing quality classification for all reservoirs are "poor" and "no baffle", while clarifier no. 2 is "poor", and the filters + clearwell are "superior". Modification is necessary for reservoirs nos. 2 and 3 by constructing baffle walls or installing diffusers in front of the inlet pipes. Reservoir no. 1 and clarifier no. 2 may need some modification as well. The filters and clearwell combination does not require modification.

2). Overall, the use of sodium chloride, step input, and flame emission photometer gives very good results.

3). A smaller sampling time interval, say 1 minute, is probably necessary as the prediction of the t_{10} is based on discrete points in the F curve.

4). The Morril's index and baffle parameter are based on discrete points in the F curve, therefore they give less accuracy to the estimation. Still, the baffle parameter is the only parameter to give a direct assessment for the CT concept.

5). The Wolf - Resnick, Rebhun - Argaman, and CMRs - in - series models are based on empirical parameters. These models are better than those based on discrete points as they consider the whole curve. However, these models may not always give good estimations of the t_{10}, especially for a system without baffles. In a

system without baffles, the momentum may be dominant, and in that case the jet model seems to give better estimations of the t_{10}.

6). The jet model was applied to determine if the momentum from the inlet was the cause of the very small t_{10} values for reservoirs nos. 2 and 3. The jet model appeared to indicate that the inlet jet was responsible to the fast passage of the tracer through the reservoir. Early portions of the residence time distribution were predicted using the jet model without calibration (parameters were taken directly from the references). Application of the jet model may be possible at other sites with similar unbaffled conditions. The model is only applicable, in this case, up to $C/C_o = 0.2$ which is about the flux associated with the core of the jet. For a well designed reservoir, when the momentum is not dominant, the model is not applicable. The major finding of using the jet model is showing the importance of momentum dissipating of the inlet if long residence times are desired.

7). The simplified jet model is another method to assess the t_{10}. As the constant C_1 was found to be relatively constant, it provides another indication that early portions of the residence time distribution were dominated by the jet / momentum effect for reservoirs nos. 2 and 3.

8). All models described can provide valuable information in assessing the residence time distribution. However, limitation of each must be considered when they are applied.

9). Three comments are addressed to the Guidance Manual (1989) / the SWTR:

a) the assessment of other t_{10} values at different flow rates, which is based only on the flow rates and the t_{10} values, may not be correct as it does not consider the water level (volume) and other factors,

b) suggestion to use the baffle parameter (t_{10}/T_d) to classify the performance of a system might not be correct since it is based on discrete points only. A small error

in the critical area may give a significant error in the system performance prediction, and

c) the Rebhun - Argaman model that is suggested to predict the t_{10} should be used cautiously. This model cannot be applied in a system which is dominated by the momentum effect.

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9.0 APPENDICES

APPENDIX 1: F CURVE DEVELOPMENT

SAMPLING NO:	1
LOCATION:	**Filters & Clearwell**
FLOW (ML/d)	180
SAMPLING DATE:	16-Feb-93
TESTING DATE:	20-Feb-93
STANDARD MADE:	10-Feb-93

STANDARDIZATION

mg/L Na	Initial Reading	Final Reading	Average
0.0	0.0	0.0	0.0
5.0	32.5	32.5	32.5
10.0	58.5	59.0	58.8
15.0	81.0	82.0	81.5
20.0	100.0	100.5	100.3

Regression Statistics

Multiple R	0.994
R Square	0.989
Adjusted R Square	0.985
Standard Error	0.958
Observations	5

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	247.248	247.248	269.482	0.000
Residual	3	2.752	0.917		
Total	4	250.000			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-0.821	0.786	-1.045	0.355	-3.323	1.681
x1	0.198	0.012	16.416	0.000	0.160	0.237

General Equation: y=0.196x-0.821

TEST NO. 1
FILTERS & CLEARWELL (180 ML/d)

NaBack(mg/L)=	3.72	m=	0.2		m=	0.2		m=	0.2		
NaFinal(mg/L)=	18.31	b=	-1.3		b=	-1.0		b=	-1.3		
NaTracer(mg/L)=	14.58										

Filter #1 Inlet				Filter #1 Outlet				Filter #2 Inlet			
Time	Reading	Conc. Na	C/Co	Time	Reading	Conc. Na	C/Co	Time	Reading	Conc. Na	C/Co
min		mg/L		min		mg/L		min		mg/L	
0.6	25.0	3.7	0.00	0.0	23.0	3.7	0.00	0.0	24.5	3.8	0.00
1.8	28.0	4.3	0.04	1.3	23.0	3.7	0.00	1.3	24.0	3.7	0.00
2.8	44.5	7.6	0.27	2.4	23.0	3.7	0.00	2.8	47.0	8.4	0.32
3.7	56.5	10.0	0.43	3.5	23.0	3.7	0.00	3.2	63.0	11.7	0.55
4.7	67.0	12.1	0.57	4.7	23.0	3.7	0.00	4.2	65.0	12.2	0.58
5.7	67.0	12.1	0.57	5.8	23.5	3.8	0.01	5.2	58.0	10.7	0.48
6.7	69.5	12.6	0.61	7.0	26.5	4.4	0.05	6.2	69.0	13.0	0.64
7.7	67.0	12.1	0.57	8.3	30.0	5.1	0.10	7.3	63.5	11.9	0.56
8.8	74.0	13.5	0.67	9.3	35.0	6.2	0.17	8.3	65.0	12.2	0.58
9.6	74.0	13.5	0.67	10.3	39.0	7.0	0.22	9.2	72.0	13.6	0.68
10.7	85.0	15.7	0.82	11.5	43.0	7.8	0.28	10.2	80.0	15.3	0.79
11.7	81.5	15.0	0.77	12.6	46.0	8.4	0.32	11.2	82.0	15.7	0.82
13.0	82.0	15.1	0.78	13.7	50.5	9.3	0.38	12.2	82.0	15.7	0.82
15.0	86.0	15.9	0.83	14.8	54.0	10.0	0.43	14.5	78.0	14.9	0.76
17.0	85.5	15.8	0.83	16.5	58.0	10.8	0.49	16.0	85.0	16.3	0.86
19.0	89.0	16.5	0.87	18.3	64.5	12.2	0.58	18.5	86.0	16.5	0.88
21.0	87.0	16.1	0.85	20.3	69.0	13.1	0.64	20.5	87.0	16.7	0.89
23.0	90.0	16.6	0.89	22.3	73.0	13.9	0.70	22.0	85.0	16.3	0.86
35.0	94.5	17.5	0.95	24.3	77.0	14.7	0.75	34.0	90.0	17.3	0.93
45.0	95.0	17.6	0.95	26.3	79.5	15.2	0.79	44.0	93.0	18.0	0.98
55.0	99.0	18.4	1.01	31.3	84.0	16.1	0.85	54.0	93.0	18.0	0.98
65.0	97.5	18.1	0.99	36.3	88.0	16.9	0.91	64.0	94.0	18.2	0.99
95.0	98.0	18.2	1.00	41.3	90.0	17.4	0.93	94.0	93.5	18.1	0.98
124.6	98.5	18.3	1.00	46.3	91.0	17.6	0.95	123.5	94.0	18.2	0.99
150.0	98.5	18.3	1.00	51.3	96.0	18.6	1.02	151.0	95.0	18.4	1.00
175.0	98.0	18.2	1.00	56.3	96.0	18.6	1.02	176.0	95.0	18.4	1.00
				65.0	97.0	18.8	1.03				
				95.0	94.0	18.2	0.99				
				125.0	95.0	18.4	1.00				
				155.0	94.0	18.2	0.99				
				180.0	95.0	18.4	1.00				

Grnl Eqn:	y=0.199x-0.821 (INLET)	
Na start:	3.72	
Na finish:	18.31	
Initial:	22.83	(avearge of 3 first samples)
Steady:	96.15	(average of 8 last samples from OUTLET)
		(assumed Steady for Inlet = Outlet)

m=	0.2	m=	0.2	m=	0.2	m=	0.2
b=	-0.7	b=	-1.2	b=	-1.5	b=	-1.1

Filter #2 Outlet				Filter #3 Inlet				Filter #3 Outlet				Filter #4 Inlet			
Time	Reading	Conc. Na	C/Co	Time	Reading	Conc. Na	C/Co	Time	Reading	Conc. Na	C/Co	Time	Reading	Conc. Na	C/Co
min		mg/L		min		mg/L		min		mg/L		min		mg/L	
0.7	22.0	3.6	-0.01	0.5	25.0	3.7	0.00	0.8	25.0	3.7	0.00	0.2	28.0	4.6	0.06
1.9	22.5	3.7	0.00	1.7	25.0	3.7	0.00	3.0	25.0	3.7	0.00	1.2	23.0	3.6	-0.01
2.9	23.0	3.8	0.01	2.8	62.0	11.0	0.50	4.7	25.5	3.8	0.00	2.2	24.0	3.8	0.01
4.0	22.5	3.7	0.00	4.0	56.0	9.9	0.42	6.1	25.0	3.7	0.00	3.3	54.0	10.0	0.43
5.3	22.5	3.7	0.09	5.0	39.0	6.5	0.19	7.6	27.5	4.2	0.03	4.5	82.0	15.7	0.82
6.5	24.5	4.1	0.03	6.1	66.0	11.8	0.56	8.9	33.0	5.4	0.11	5.6	50.0	9.2	0.37
7.6	27.5	4.7	0.07	7.2	51.0	8.9	0.35	10.4	39.0	6.6	0.20	6.7	66.0	12.4	0.60
8.8	31.0	5.4	0.12	8.3	69.0	12.4	0.60	11.8	43.0	7.4	0.25	7.7	70.5	13.4	0.66
9.8	34.5	6.1	0.16	9.5	77.0	14.0	0.71	13.3	49.5	8.8	0.35	9.0	65.0	12.2	0.58
10.9	38.5	6.9	0.22	10.6	81.0	14.8	0.76	14.7	54.0	9.7	0.41	10.1	69.0	13.0	0.64
12.0	42.5	7.7	0.27	13.0	83.0	15.2	0.79	17.0	62.0	11.4	0.53	12.0	88.0	16.9	0.91
13.2	46.5	8.5	0.33	15.0	74.0	13.4	0.67	18.5	65.5	12.1	0.58	14.0	81.5	15.6	0.81
14.3	47.0	8.6	0.33	17.0	79.0	14.4	0.73	19.7	70.0	13.1	0.64	16.0	81.0	15.5	0.81
15.2	56.5	10.5	0.46	19.0	83.0	15.2	0.79	22.0	74.0	13.9	0.70	18.0	82.0	15.7	0.82
17.3	63.0	11.8	0.55	21.0	87.0	16.0	0.84	24.0	78.0	14.7	0.75	20.0	84.0	16.1	0.85
19.3	68.0	12.8	0.62	33.0	91.0	16.8	0.90	26.0	81.5	15.5	0.80	30.0	91.0	17.6	0.95
21.3	73.0	13.7	0.69	43.0	98.0	18.2	0.99	28.0	83.0	15.8	0.83	32.0	90.5	17.5	0.94
23.3	77.0	14.5	0.74	53.0	99.0	18.4	1.00	30.0	85.5	16.3	0.86	42.0	92.5	17.9	0.97
25.3	80.0	15.1	0.78	63.0	100.0	18.6	1.02	38.0	91.5	17.5	0.95	53.0	94.0	18.2	0.99
30.3	86.0	16.3	0.86	93.0	98.0	18.2	0.99	43.0	92.0	17.6	0.95	62.0	94.0	18.2	0.99
35.3	90.0	17.1	0.92	122.6	98.0	18.2	0.99	48.0	92.0	17.6	0.95	90.0	93.5	18.1	0.98
40.3	92.0	17.5	0.95	152.0	99.0	18.4	1.00	53.0	92.0	17.6	0.95	121.6	95.0	18.4	1.00
45.3	92.0	17.5	0.95	174.8	99.0	18.4	1.00	58.0	95.0	18.3	1.00	151.7	94.0	18.2	0.99
50.3	94.5	18.0	0.98					63.0	95.0	18.3	1.00	176.7	95.0	18.4	1.00
55.7	98.0	18.7	1.03					67.0	98.0	18.9	1.04				
66.0	96.0	18.3	1.00					97.0	96.0	18.5	1.01				
96.0	97.0	18.5	1.01					127.0	95.5	18.4	1.00				
126.0	96.0	18.3	1.00					157.0	95.0	18.3	1.00				
181.0	95.0	18.1	0.99					182.0	95.0	18.3	1.00				

m=	0.2	m=	0.2	m=	0.2	m=	0.2
b=	-0.5	b=	-0.6	b=	-0.6	b=	-0.9

Filter #4 Outlet				Filter #5 Inlet				Filter #5 Outlet				Filter #6 Inlet			
Time	Reading	Conc. Na	C/Co	Time	Reading	Conc. Na	C/Co	Time	Reading	Conc. Na	C/Co	Time	Reading	Conc. Na	C/Co
min		mg/L		min		mg/L		min		mg/L		min		mg/L	
0.0	22.0	3.7	0.00	0.7	22.0	3.8	0.00	0.0	22.5	3.8	0.00	0.0	23.0	3.7	0.00
2.0	22.0	3.7	0.00	1.8	21.0	3.6	-0.01	2.0	22.0	3.7	0.00	1.2	22.5	3.6	-0.01
3.7	22.5	3.8	0.00	2.9	22.0	3.8	0.00	3.2	22.5	3.8	0.00	2.4	24.0	3.9	0.01
5.3	22.5	3.8	0.00	3.9	58.0	10.9	0.49	4.4	22.5	3.8	0.00	3.4	22.0	3.5	-0.02
6.9	25.0	4.3	0.04	4.7	84.0	16.0	0.84	5.5	23.0	3.9	0.01	4.3	30.0	5.1	0.09
8.3	29.0	5.0	0.09	6.0	56.0	10.5	0.47	6.9	23.5	3.9	0.02	5.5	45.0	8.1	0.30
9.7	34.5	6.1	0.16	7.0	81.0	15.4	0.80	8.0	24.0	4.0	0.02	6.5	83.0	15.7	0.82
11.2	40.0	7.2	0.24	8.7	54.0	10.1	0.44	9.3	27.0	4.6	0.06	7.5	73.5	13.8	0.69
12.5	44.5	8.0	0.29	10.2	57.0	10.7	0.48	10.5	30.5	5.3	0.11	9.6	52.0	9.5	0.39
13.8	49.5	9.0	0.36	12.0	70.0	13.3	0.65	11.5	35.0	6.2	0.17	11.3	67.5	12.6	0.61
15.3	54.5	9.9	0.43	13.5	70.0	13.3	0.65	12.5	38.0	6.8	0.21	12.8	64.0	11.9	0.56
17.8	61.5	11.3	0.52	15.3	78.0	14.8	0.76	13.5	41.5	7.4	0.25	14.5	81.0	15.3	0.79
19.0	67.0	12.3	0.59	17.3	88.0	16.8	0.90	14.5	45.0	8.1	0.30	16.4	78.5	14.8	0.76
21.0	71.5	13.2	0.65	19.2	88.0	16.8	0.90	16.0	49.5	9.0	0.36	18.2	78.0	14.7	0.75
23.0	77.5	14.4	0.73	21.3	91.0	17.4	0.94	17.5	54.0	9.9	0.42	20.4	79.0	14.9	0.76
25.0	80.5	14.9	0.77	31.0	96.0	18.4	1.01	18.5	56.5	10.3	0.45	22.5	86.0	16.3	0.86
27.0	82.5	15.3	0.80	41.0	95.0	18.2	0.99	19.5	59.0	10.8	0.49	40.0	89.0	16.9	0.90
29.0	85.0	15.8	0.83	51.0	95.0	18.2	0.99	21.0	64.5	11.9	0.56	50.0	91.0	17.3	0.93
35.0	90.5	16.9	0.90	61.0	95.5	18.3	1.00	23.0	71.0	13.1	0.65	60.0	93.0	17.7	0.96
40.0	91.0	17.0	0.91	91.0	95.0	18.2	0.99	25.0	75.0	13.9	0.70	120.0	98.0	18.7	1.03
45.0	91.5	17.1	0.91	120.9	95.5	18.3	1.00	27.0	84.0	15.7	0.82	149.1	97.0	18.5	1.01
50.0	94.0	17.5	0.95	150.5	96.0	18.4	1.01	29.0	82.0	15.3	0.79	178.1	93.5	17.8	0.96
55.0	96.0	17.9	0.97	177.0	95.0	18.2	0.99	31.0	83.0	15.5	0.81				
60.0	97.0	18.1	0.99					36.0	86.5	16.1	0.85				
68.0	98.0	18.3	1.00					41.0	89.0	16.6	0.88				
98.0	98.0	18.3	1.00					46.0	90.0	16.8	0.90				
128.0	98.0	18.3	1.00					51.0	92.0	17.2	0.92				
158.0	98.0	18.3	1.00					55.0	94.0	17.6	0.95				
183.0	98.0	18.3	1.00					60.0	96.0	18.0	0.98				
								85.0	97.0	18.2	0.99				
								115.0	98.0	18.4	1.00				
								145.0	97.0	18.2	0.99				
								175.0	98.0	18.4	1.00				

m= 0.2
b= -0.7

m= 0.2
b= -1.0

Filter #6 Outlet				End of Clearwell				
Time	Reading	Conc. Na	C/Co	Time	T/Td	Reading	Conc. Na	C/Co
min		mg/L		min	Td=29		mg/L	
0.0	22.0	3.8	0.00	0.0	0.00	24.0	3.8	0.01
1.8	21.5	3.7	0.00	2.0	0.07	24.0	3.8	0.01
2.7	22.0	3.8	0.00	4.0	0.14	23.5	3.7	0.00
3.7	22.0	3.8	0.00	6.0	0.21	23.5	3.7	0.00
5.0	22.0	3.8	0.00	8.0	0.28	23.0	3.6	-0.01
6.2	22.0	3.8	0.00	10.0	0.34	23.0	3.6	-0.01
7.5	22.0	3.8	0.00	12.0	0.41	23.0	3.6	-0.01
8.8	22.5	3.9	0.01	14.0	0.48	23.5	3.7	0.00
10.0	25.0	4.4	0.04	16.0	0.55	23.5	3.7	0.00
11.0	29.0	5.2	0.10	18.0	0.62	24.5	3.9	0.01
12.0	32.0	5.8	0.14	20.0	0.69	27.0	4.4	0.05
13.0	34.0	6.2	0.17	22.0	0.76	31.5	5.3	0.11
14.0	38.0	7.0	0.22	24.0	0.83	36.0	6.2	0.17
15.5	43.0	8.0	0.29	26.0	0.90	37.0	6.4	0.19
16.8	46.0	8.6	0.33	28.0	0.97	44.5	7.9	0.29
18.0	51.0	9.6	0.40	30.0	1.03	51.5	9.4	0.39
19.0	55.5	10.5	0.46	32.0	1.10	58.0	10.7	0.48
20.0	58.5	11.1	0.51	34.0	1.17	57.0	10.5	0.46
22.0	65.0	12.4	0.60	36.0	1.24	66.0	12.3	0.59
24.0	70.0	13.4	0.66	38.0	1.31	68.0	12.7	0.61
26.0	74.0	14.2	0.72	40.0	1.38	72.0	13.5	0.67
28.0	77.0	14.8	0.76	42.0	1.45	66.5	12.4	0.59
30.0	78.0	15.0	0.77	44.0	1.52	77.0	14.5	0.74
35.0	83.0	16.0	0.84	46.0	1.59	81.0	15.3	0.79
40.0	88.0	17.0	0.91	48.0	1.66	72.5	13.6	0.67
45.0	93.0	18.0	0.98	50.0	1.72	77.5	14.6	0.74
50.0	92.0	17.8	0.97	52.0	1.79	83.0	15.7	0.82
55.0	92.0	17.8	0.97	54.0	1.86	83.0	15.7	0.82
60.0	94.0	18.2	1.00	56.0	1.93	81.0	15.3	0.79
85.0	95.0	18.4	1.01	58.0	2.00	82.5	15.6	0.81
115.0	93.0	18.0	0.98	60.0	2.07	82.5	15.6	0.81
145.0	94.0	18.2	1.00	65.0	2.24	87.0	16.5	0.87
175.0	96.0	18.6	1.02	70.0	2.41	87.5	16.6	0.88
				75.0	2.59	83.5	15.8	0.83
				105.0	3.62	87.0	16.5	0.87
				110.0	3.79	87.0	16.5	0.87
				115.0	3.97	89.0	16.9	0.90
				120.0	4.14	90.0	17.1	0.92
				125.0	4.31	85.5	16.2	0.85
				130.0	4.48	90.0	17.1	0.92
				135.0	4.66	92.5	17.6	0.95
				140.0	4.83	93.0	17.7	0.96
				145.0	5.00	93.0	17.7	0.96
				150.0	5.17	90.0	17.1	0.92
				155.0	5.34	95.0	18.1	0.98
				160.0	5.52	89.0	16.9	0.90
				165.0	5.69	91.5	17.4	0.94
				170.0	5.86	89.0	16.9	0.90
				175.0	6.03	86.5	16.4	0.87
				180.0	6.21	85.0	16.1	0.85

SAMPLING NO:	**2**
LOCATION:	**Filters & Clearwell**
FLOW (ML/d):	140
SAMPLING DATE:	24-Feb-93
TESTING DATE:	25-Feb-93
STANDARD MADE:	22-Feb-93

STANDARDIZATION

mg/L Na	Initial Reading	Final Reading	Average
2.0	13.5	13.0	13.3
5.0	32.5	32.0	32.3
7.0	44.5	43.0	43.8
10.0	59.5	58.0	58.8
12.0	68.0	67.0	67.5
15.0	80.5	80.0	80.3
17.0	88.0	88.0	88.0
20.0	100.0	100.0	100.0

Regression Statistics

Multiple R	0.996
R Square	0.992
Adjusted R Square	0.990
Standard Error	0.616
Observations	8

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	265.725	265.725	700.872	0.000
Residual	6	2.275	0.379		
Total	7	268.000			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.652	0.525	-3.146	0.016	-2.937	-0.367
x1	0.209	0.008	26.474	0.000	0.190	0.229

General Equation: y=0.209x-1.652

TEST NO. 2
FILTERS & CLEARWELL (140 ML/d)

NaBack(mg/L)=	2.62	m=	0.2	m=	0.2
NaFinal(mg/L)=	15.10	b=	-1.7	b=	-1.5
NaTracer(mg/L)=	12.48				

Filter #1 Outlet					Filter #1 Outlet				
Time		Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co
min	min		mg/L		min	min		mg/L	
00:05:00	0.0	20.5	2.6	0.00	00:05:35	0.6	19.0	2.5	-0.01
00:08:00	3.0	20.5	2.6	0.00	00:07:15	2.3	19.5	2.6	0.00
00:09:00	4.0	21.0	2.7	0.01	00:08:30	3.5	20.0	2.7	0.01
00:10:00	5.0	21.0	2.7	0.01	00:09:30	4.5	20.5	2.8	0.02
00:11:00	6.0	21.0	2.7	0.01	00:10:30	5.5	20.0	2.7	0.01
00:12:00	7.0	22.0	2.9	0.02	00:11:30	6.5	20.0	2.7	0.01
00:13:00	8.0	22.5	3.0	0.03	00:12:30	7.5	22.0	3.1	0.04
00:14:00	9.0	25.5	3.6	0.08	00:13:25	8.4	24.0	3.6	0.08
00:15:00	10.0	27.5	4.0	0.11	00:14:30	9.5	27.0	4.2	0.13
00:16:00	11.0	31.0	4.8	0.17	00:15:30	10.5	30.5	4.9	0.19
00:17:00	12.0	32.5	5.1	0.20	00:16:30	11.5	33.5	5.6	0.24
00:18:00	13.0	35.5	5.7	0.25	00:17:30	12.5	34.5	5.8	0.25
00:19:00	14.0	37.5	6.1	0.28	00:18:30	13.5	38.0	6.5	0.31
00:20:00	15.0	41.5	6.9	0.35	00:19:30	14.5	41.0	7.2	0.36
00:21:00	16.0	43.5	7.4	0.38	00:20:30	15.5	42.5	7.5	0.39
00:22:00	17.0	47.0	8.1	0.44	00:21:30	16.5	45.0	8.0	0.43
00:23:00	18.0	50.0	8.7	0.49	00:22:30	17.5	47.5	8.5	0.47
00:24:00	19.0	51.5	9.0	0.51	00:23:30	18.5	48.5	8.8	0.49
00:25:00	20.0	53.0	9.3	0.54	00:24:30	19.5	52.5	9.6	0.56
00:27:00	22.0	57.0	10.2	0.60	00:25:30	20.5	55.0	10.1	0.60
00:29:00	24.0	61.0	11.0	0.67	00:28:00	23.0	59.5	11.1	0.68
00:31:00	26.0	62.5	11.3	0.70	00:30:00	25.0	61.5	11.5	0.71
00:33:09	28.2	65.0	11.8	0.74	00:32:00	27.0	66.0	12.5	0.79
00:35:00	30.0	67.5	12.3	0.78	00:34:00	29.0	67.5	12.8	0.81
00:40:00	35.0	71.0	13.1	0.84	00:36:00	31.0	69.5	13.2	0.85
00:45:00	40.0	77.5	14.4	0.94	00:41:00	36.0	75.0	14.4	0.94
00:50:06	45.1	77.5	14.4	0.94	00:46:00	41.0	77.5	14.9	0.98
00:55:00	50.0	78.0	14.5	0.95	00:51:00	46.0	78.5	15.1	1.00
01:00:00	55.0	79.0	14.7	0.97	00:56:00	51.0	79.5	15.3	1.02
01:05:00	60.0	79.5	14.8	0.98	01:01:00	56.0	81.5	15.7	1.05
01:36:30	91.5	80.5	15.0	0.99	01:06:00	61.0	82.0	15.8	1.06
02:06:30	121.5	82.0	15.3	1.02	01:36:00	91.0	77.7	14.9	0.99
02:36:30	151.5	81.5	15.2	1.01	02:06:00	121.0	78.5	15.1	1.00
03:06:30	181.5	79.0	14.7	0.97	02:36:00	151.0	78.5	15.1	1.00
					03:06:00	181.0	78.5	15.1	1.00

General Eqn:	y=0.209x-1.652	
Na start:	2.62	
Na finish:	15.10	
Initial:	20.4	(average of 3 first samples from each location except End of Clearwell)
Steady:	80.1	(average of 3 last samples from each location except End of Clearwell)

		m=	0.2			m=	0.2			m=	0.2			
		b=	-1.4			b=	-1.7			b=	-1.6			

Filter #3 Outlet					Filter #4 Outlet					Filter #5 Outlet				
Time		Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co
min	min		mg/L		min	min		mg/L		min	min		mg/L	
00:05:45	0.8	19.0	2.6	0.00	00:05:00	0.0	19.5	2.4	-0.01	00:05:30	0.5	20.0	2.5	-0.01
00:07:16	2.3	19.0	2.6	0.00	00:06:33	1.6	23.0	3.2	0.05	00:06:30	1.5	21.0	2.7	0.01
00:08:33	3.6	19.0	2.6	0.00	00:07:53	2.9	18.5	2.2	-0.03	00:07:30	2.5	20.5	2.6	0.00
00:09:53	4.9	19.0	2.6	0.00	00:09:15	4.3	18.5	2.2	-0.03	00:08:30	3.5	20.5	2.6	0.00
00:11:27	6.5	18.5	2.5	-0.01	00:10:33	5.6	18.0	2.1	-0.04	00:09:30	4.5	20.0	2.5	-0.01
00:12:25	7.4	19.5	2.7	0.01	00:11:43	6.7	19.0	2.3	-0.02	00:10:30	5.5	20.0	2.5	-0.01
00:13:39	8.7	21.0	3.0	0.03	00:13:02	8.0	20.5	2.7	0.00	00:11:30	6.5	20.5	2.6	0.00
00:14:56	9.9	24.5	3.8	0.09	00:14:19	9.3	24.0	3.4	0.06	00:12:30	7.5	20.5	2.6	0.00
00:16:10	11.2	29.0	4.7	0.17	00:15:34	10.6	27.5	4.1	0.12	00:13:30	8.5	21.0	2.7	0.01
00:17:29	12.5	31.5	5.2	0.21	00:16:52	11.9	31.5	5.0	0.19	00:14:30	9.5	22.0	2.9	0.02
00:18:43	13.7	34.5	5.9	0.26	00:18:06	13.1	33.0	5.3	0.22	00:15:30	10.5	25.0	3.6	0.07
00:19:58	15.0	38.0	6.6	0.32	00:19:19	14.3	36.0	6.0	0.27	00:16:30	11.5	27.5	4.1	0.12
00:21:15	16.3	41.5	7.3	0.38	00:20:36	15.6	39.5	6.7	0.33	00:17:30	12.5	30.5	4.7	0.17
00:22:32	17.5	44.5	8.0	0.43	00:21:55	16.9	43.0	7.4	0.39	00:18:30	13.5	32.0	5.0	0.19
00:23:55	18.9	48.0	8.7	0.49	00:23:17	18.3	47.0	8.3	0.45	00:19:30	14.5	36.0	5.8	0.26
00:25:01	20.0	50.5	9.2	0.53	00:24:30	19.5	49.0	8.7	0.49	00:20:30	15.5	38.5	6.4	0.30
00:27:30	22.5	56.0	10.4	0.62	00:27:00	22.0	54.0	9.8	0.57	00:21:30	16.5	43.0	7.3	0.37
00:29:30	24.5	58.5	10.9	0.66	00:29:00	24.0	57.5	10.5	0.63	00:23:30	18.5	46.0	7.9	0.42
00:31:30	26.5	61.0	11.4	0.71	00:31:00	26.0	59.5	11.0	0.67	00:24:30	19.5	47.0	8.1	0.44
00:33:30	28.5	63.5	12.0	0.75	00:33:00	28.0	61.5	11.4	0.70	00:25:30	20.5	51.0	8.9	0.51
00:35:30	30.5	66.5	12.6	0.80	00:35:00	30.0	62.5	11.6	0.72	00:27:30	22.5	56.0	10.0	0.59
00:40:30	35.5	70.0	13.3	0.86	00:40:00	35.0	69.5	13.1	0.84	00:29:30	24.5	60.0	10.8	0.66
00:45:30	40.5	73.0	14.0	0.91	00:45:00	40.0	70.5	13.3	0.86	00:31:30	26.5	63.0	11.4	0.71
00:50:30	45.5	74.5	14.3	0.93	00:50:00	45.0	74.0	14.0	0.91	00:33:30	28.5	65.0	11.9	0.74
00:55:30	50.5	75.0	14.4	0.94	00:55:00	50.0	74.5	14.1	0.92	00:35:30	30.5	69.0	12.7	0.81
01:00:30	55.5	75.5	14.5	0.95	01:00:00	55.0	74.0	14.0	0.91	00:40:30	35.5	76.0	14.1	0.92
01:05:30	60.5	78.0	15.0	0.99	01:05:00	60.0	74.0	14.0	0.91	00:45:30	40.5	75.5	14.0	0.91
01:35:30	90.5	78.5	15.1	1.00	01:35:00	90.0	75.0	14.3	0.93	00:50:30	45.5	81.0	15.2	1.01
02:05:30	120.5	78.5	15.1	1.00	02:05:00	120.0	78.0	14.9	0.98	00:55:30	50.5	81.5	15.3	1.01
02:35:30	150.5	78.5	15.1	1.00	02:35:00	150.0	79.5	15.2	1.01	01:00:30	55.5	81.0	15.2	1.01
03:05:30	180.5	78.5	15.1	1.00	03:05:00	180.0	79.5	15.2	1.01	01:05:30	60.5	80.0	15.0	0.99
										01:35:30	90.5	80.5	15.1	1.00
										02:05:30	120.5	80.5	15.1	1.00
										02:35:30	150.5	81.5	15.3	1.01
										03:05:30	180.5	80.0	15.0	0.99

m=	0.2		m=	0.2
b=	-2.0		b=	-2.5

Filter #6 Outlet					Bed of Clearwell					
Time		Reading	Conc. No.	C/Co	Time		T/Td	Reading	Conc. No.	C/Co
min	min		mg/L		min	min	Td=37		mg/L	
00:05:00	0.0	22.0	2.5	-0.01	00:05:00	0.0	0.00	23.0	2.7	0.00
00:06:00	1.0	22.5	2.6	0.00	00:07:00	7.0	0.19	23.0	2.7	0.00
00:07:00	2.0	23.0	2.7	0.01	00:09:00	9.0	0.24	23.0	2.7	0.00
00:08:00	3.0	23.0	2.7	0.01	00:11:00	11.0	0.30	23.0	2.7	0.00
00:09:00	4.0	23.0	2.7	0.01	00:13:00	13.0	0.35	22.5	2.6	0.00
00:10:00	5.0	23.0	2.7	0.01	00:15:00	15.0	0.41	22.5	2.6	0.00
00:11:00	6.0	23.0	2.7	0.01	00:17:00	17.0	0.46	22.5	2.6	0.00
00:12:00	7.0	23.0	2.7	0.01	00:19:00	19.0	0.51	23.0	2.7	0.00
00:13:00	8.0	23.0	2.7	0.01	00:21:00	21.0	0.57	23.0	2.7	0.00
00:14:00	9.0	23.5	2.8	0.02	00:23:00	23.0	0.62	23.0	2.7	0.00
00:15:00	10.0	23.5	2.8	0.02	00:25:00	25.0	0.68	22.5	2.6	0.00
00:16:00	11.0	25.5	3.2	0.05	00:27:00	27.0	0.73	24.0	2.9	0.02
00:17:00	12.0	28.5	3.9	0.10	00:29:00	29.0	0.78	25.0	3.1	0.04
00:18:00	13.0	31.0	4.4	0.14	00:31:00	31.0	0.84	31.0	4.4	0.14
00:19:00	14.0	32.5	4.7	0.17	00:33:00	33.0	0.89	31.0	4.4	0.14
00:20:00	15.0	37.5	5.7	0.25	00:35:00	35.0	0.95	33.0	4.8	0.18
00:21:00	16.0	39.5	6.1	0.28	00:37:00	37.0	1.00	38.5	6.0	0.27
00:22:00	17.0	44.0	7.1	0.36	00:39:00	39.0	1.05	42.0	6.8	0.33
00:23:00	18.0	45.5	7.4	0.38	00:41:00	41.0	1.11	49.5	8.4	0.46
00:24:00	19.0	48.0	7.9	0.42	00:43:00	43.0	1.16	55.0	9.6	0.56
00:25:00	20.0	50.5	8.4	0.46	00:45:00	45.0	1.22	56.5	9.9	0.58
00:27:00	22.0	56.0	9.5	0.55	00:47:00	47.0	1.27	61.0	10.9	0.66
00:29:00	24.0	60.5	10.5	0.63	00:49:00	49.0	1.32	62.5	11.2	0.69
00:31:00	26.0	64.0	11.2	0.69	00:51:00	51.0	1.38	55.0	9.6	0.56
00:33:00	28.0	67.0	11.8	0.74	00:53:00	53.0	1.43	65.5	11.8	0.74
00:35:00	30.0	69.0	12.2	0.77	00:55:00	55.0	1.49	71.0	13.0	0.83
00:40:00	35.0	76.0	13.7	0.88	00:57:00	57.0	1.54	66.5	12.1	0.76
00:45:00	40.0	80.5	14.6	0.96	00:59:00	59.0	1.59	75.0	13.9	0.90
00:50:00	45.0	82.0	14.9	0.98	01:01:00	61.0	1.65	73.0	13.5	0.87
00:55:00	50.0	82.0	14.9	0.98	01:03:00	63.0	1.70	77.5	14.4	0.95
01:00:00	55.0	83.5	15.2	1.01	01:05:00	65.0	1.76	77.0	14.3	0.94
01:05:00	60.0	83.5	15.2	1.01	01:10:00	70.0	1.89	77.5	14.4	0.95
01:34:00	89.0	83.5	15.2	1.01	01:15:00	75.0	2.03	73.0	13.5	0.87
02:05:00	120.0	84.0	15.3	1.02	01:20:00	80.0	2.16	72.0	13.3	0.85
02:34:00	149.0	82.5	15.0	0.99	01:25:00	85.0	2.30	81.0	15.2	1.01
03:04:00	179.0	82.5	15.0	0.99	01:30:00	90.0	2.43	78.5	14.7	0.96
					01:45:00	105.0	2.84	81.5	15.3	1.02
					01:50:00	110.0	2.97	79.5	14.9	0.98
					01:57:00	117.0	3.16	75.5	14.0	0.91
					02:00:00	120.0	3.24	79.5	14.9	0.98
					02:05:00	125.0	3.38	77.5	14.4	0.95
					02:15:00	135.0	3.65	78.5	14.7	0.96
					02:20:00	140.0	3.78	79.0	14.8	0.97
					02:25:00	145.0	3.92	84.5	16.0	1.07
					02:30:00	150.0	4.05	85.0	16.1	1.08
					02:33:30	153.5	4.15	85.0	16.1	1.08
					02:40:00	160.0	4.32	86.0	16.3	1.09
					02:45:00	165.0	4.46	74.0	13.7	0.89
					02:50:00	170.0	4.59	80.5	15.1	1.00
					03:00:00	180.0	4.86	80.5	15.1	1.00
					03:04:00	184.0	4.97	83.0	15.6	1.04

SAMPLING NO:	3	
LOCATION	Clarifier 2	
FLOW (ML/d)	180	
SAMPLING DATE	05-Mar-93	
TESTING DATE	08-Mar-93	(use these data)
	09-Mar-93	(check the data)
	19-Mar-93	(check the sludge effect)
	21-Mar-93	(check the sludge effect)
STANDARD MADE	22-Feb-93	

STANDARDIZATION

mg/L Na	Initial Reading	Initial Reading	Average
2.0	14.0	14.0	14.0
5.0	32.5	32.5	32.5
7.0	43.0	42.5	42.8
10.0	58.5	59.0	58.8
12.0	67.0	68.0	67.5
17.0	88.5	89.0	88.8
20.0	100.0	100.0	100.0

Regression Statistics

Multiple R	0.996
R Square	0.993
Adjusted R Square	0.991
Standard Error	0.599
Observations	7

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	247.918	247.918	690.140	0.000
Residual	5	1.796	0.359		
Total	6	249.714			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.702	0.514	-3.309	0.016	-3.024	-0.380
x1	0.210	0.008	26.271	0.000	0.190	0.231

General Equation: y=0.210x-1.702

TEST NO. 3
CLARIFIER NO. 2 (180 ML/d)

Na back (mg/L)=	3.59	m=	0.2	0.2
Na Final (mg/L)=	13.20	b=	-1.7	-1.9
Na Tracer (mg/L)	9.61			

Effluent						Bottom Draft Tube				
Time		T/Td	Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co
min	min	Td=84		mg/L		min	min		mg/L	
00:03:30	0.5	0.01	25.0	3.6	0.00	00:03:00	0.0	25.0	3.5	-0.01
00:05:50	2.8	0.03	25.0	3.6	0.00	00:04:00	1.0	26.0	3.7	0.01
00:08:20	5.3	0.06	25.0	3.6	0.00	00:05:00	2.0	27.5	4.0	0.04
00:10:00	7.0	0.08	25.5	3.7	0.01	00:06:00	3.0	28.5	4.2	0.07
00:12:00	9.0	0.10	25.5	3.7	0.01	00:07:00	4.0	31.0	4.8	0.12
00:14:00	11.0	0.13	25.0	3.6	0.00	00:08:00	5.0	33.5	5.3	0.18
00:16:00	13.0	0.15	25.0	3.6	0.00	00:09:00	6.0	34.5	5.5	0.20
00:18:00	15.0	0.17	25.0	3.6	0.00	00:10:00	7.0	37.5	6.2	0.27
00:20:00	17.0	0.20	25.0	3.6	0.00	00:11:00	8.0	40.0	6.7	0.32
00:22:00	19.0	0.22	26.0	3.8	0.02	00:12:00	9.0	42.0	7.1	0.37
00:24:00	21.0	0.24	28.0	4.2	0.07	00:13:00	10.0	43.0	7.3	0.39
00:26:00	23.0	0.27	28.5	4.3	0.08	00:14:00	11.0	43.0	7.3	0.39
00:28:00	25.0	0.29	29.0	4.4	0.09	00:15:00	12.0	43.5	7.4	0.40
00:30:00	27.0	0.31	31.0	4.9	0.13	00:16:00	13.0	45.5	7.9	0.44
00:32:00	29.0	0.34	31.0	4.9	0.13	00:17:00	14.0	46.0	8.0	0.46
00:34:00	31.0	0.36	33.0	5.3	0.18	00:18:00	15.0	45.5	7.9	0.44
00:36:00	33.0	0.38	34.0	5.5	0.20	00:19:00	16.0	46.0	8.0	0.46
00:38:30	35.0	0.41	37.5	6.2	0.27	00:20:00	17.0	47.0	8.2	0.48
00:40:00	37.0	0.43	37.5	6.2	0.27	00:21:00	18.0	47.0	8.2	0.48
00:42:00	39.0	0.45	38.5	6.4	0.30	00:22:00	19.0	48.0	8.4	0.50
00:44:00	41.0	0.48	39.0	6.6	0.31	00:23:00	20.0	48.5	8.5	0.51
00:46:00	43.0	0.50	40.5	6.9	0.34	00:24:00	21.0	48.0	8.4	0.50
00:50:00	47.0	0.55	42.0	7.2	0.37	00:25:00	22.0	50.0	8.8	0.54
00:52:00	49.0	0.57	44.0	7.6	0.42	00:26:00	23.0	50.0	8.8	0.54
00:54:00	51.0	0.59	44.5	7.7	0.43	00:27:00	24.0	50.5	8.9	0.56
00:56:00	53.0	0.62	45.5	7.9	0.45	00:28:00	25.0	51.0	9.0	0.57
00:58:00	55.0	0.64	47.0	8.2	0.48	00:29:00	26.0	52.5	9.4	0.60
01:00:00	57.0	0.66	47.5	8.3	0.49	00:30:00	27.0	53.5	9.6	0.62
01:02:00	59.0	0.69	48.0	8.5	0.51	00:31:00	28.0	53.0	9.5	0.61
01:07:00	64.0	0.74	50.0	8.9	0.55	00:32:00	29.0	53.5	9.6	0.62
01:12:00	69.0	0.80	53.0	9.5	0.62	00:33:00	30.0	53.0	9.5	0.61
01:17:00	74.0	0.86	53.3	9.6	0.63	00:38:00	35.0	55.0	9.9	0.66
01:23:00	80.0	0.93	56.0	10.1	0.68	00:43:00	40.0	57.0	10.3	0.70
01:27:30	84.5	0.98	57.5	10.5	0.71	00:48:00	45.0	57.0	10.3	0.70
01:33:00	90.0	1.05	60.0	11.0	0.77	00:53:00	50.0	58.5	10.6	0.73
01:38:00	95.0	1.10	60.0	11.0	0.77	00:58:00	55.0	60.5	11.1	0.78
01:45:00	102.0	1.19	61.5	11.3	0.80	01:03:00	60.0	63.0	11.6	0.83
01:50:00	107.0	1.24	62.5	11.5	0.82	01:18:00	75.0	65.0	12.0	0.88
01:55:00	112.0	1.30	64.0	11.8	0.86	01:33:00	90.0	67.0	12.5	0.92
02:00:00	117.0	1.36	64.5	11.9	0.87	01:48:00	105.0	69.0	12.9	0.97
02:15:00	132.0	1.53	67.0	12.5	0.92	02:03:00	120.0	70.0	13.1	0.99
02:30:00	147.0	1.71	68.0	12.7	0.95	02:30:00	147.0	70.5	13.2	1.00
02:45:00	162.0	1.88	70.5	13.2	1.00	03:00:00	177.0	70.5	13.2	1.00
03:01:00	178.0	2.07	70.5	13.2	1.00					

General Eqn: y=0.210x-1.702

Na start:	3.6	
Na finish:	13.2	
Initial:	25.2	(average of 2 first samples from each location)
Steady:	71.0	(average of 2 last samples from each location)

Note: Bottom Draft Tube is assumed as the inlet

0.2
-1.9

Top Draft Tube					Manhole					Point #1				
Time		Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co
min	min		mg/L		min	min		mg/L		min	min		mg/L	
00:03:00	0.0	25.5	3.5	-0.01	00:04:30	1.5	25.0	3.4	-0.02	00:03:00	0.0	24.5	3.4	-0.02
00:04:00	1.0	26.0	3.6	0.01	00:06:55	3.9	26.0	3.6	0.00	00:04:00	1.0	26.0	3.7	0.02
00:05:00	2.0	37.0	6.0	0.25	00:08:55	5.9	26.0	3.6	0.00	00:05:00	2.0	25.0	3.5	-0.01
00:06:00	3.0	41.0	6.9	0.34	00:10:55	7.9	34.0	5.3	0.18	00:06:00	3.0	25.5	3.6	0.01
00:07:00	4.0	46.0	7.9	0.45	00:13:00	10.0	25.0	3.4	-0.02	00:07:00	4.0	28.0	4.4	0.08
00:08:00	5.0	50.5	8.9	0.55	00:15:00	12.0	27.0	3.8	0.02	00:08:00	5.0	30.0	4.6	0.10
00:09:00	6.0	50.0	8.8	0.54	00:17:00	14.0	26.0	3.6	0.00	00:09:00	6.0	32.0	5.0	0.15
00:10:00	7.0	47.5	8.3	0.49	00:19:00	16.0	29.0	4.2	0.07	00:10:00	7.0	32.5	5.1	0.16
00:11:00	8.0	50.0	8.8	0.54	00:21:00	18.0	26.0	3.6	0.00	00:11:00	8.0	36.0	5.8	0.23
00:12:00	9.0	51.0	9.0	0.56	00:23:00	20.0	26.0	3.6	0.00	00:12:00	9.0	37.0	6.0	0.25
00:13:00	10.0	51.5	9.1	0.58	00:25:00	22.0	27.0	3.8	0.02	00:13:00	10.0	38.0	6.2	0.28
00:14:00	11.0	58.0	10.5	0.72	00:27:00	24.0	28.0	4.0	0.04	00:14:00	11.0	37.5	6.1	0.26
00:15:00	12.0	57.0	10.3	0.70	00:29:00	26.0	28.0	4.0	0.04	00:15:00	12.0	39.0	6.5	0.30
00:16:00	13.0	57.5	10.4	0.71	00:31:00	28.0	28.0	4.0	0.04	00:16:00	13.0	40.0	6.7	0.32
00:17:00	14.0	59.0	10.7	0.74	00:33:00	30.0	29.0	4.2	0.07	00:17:00	14.0	39.5	6.6	0.31
00:18:00	15.0	58.0	10.5	0.72	00:35:00	32.0	30.5	4.6	0.10	00:18:00	15.0	42.0	7.1	0.36
00:19:00	16.0	60.0	10.9	0.77	00:37:00	34.0	34.0	5.3	0.18	00:19:00	16.0	42.5	7.2	0.37
00:20:00	17.0	58.5	10.6	0.73	00:39:00	36.0	33.0	5.1	0.16	00:20:00	17.0	42.0	7.1	0.36
00:21:00	18.0	57.5	10.4	0.71	00:41:00	38.0	34.0	5.3	0.18	00:21:00	18.0	43.5	7.4	0.39
00:22:00	19.0	60.0	10.9	0.77	00:43:00	40.0	35.5	5.6	0.21	00:22:00	19.0	44.5	7.6	0.42
00:23:00	20.0	62.0	11.4	0.81	00:47:00	44.0	40.0	6.6	0.31	00:23:00	20.0	44.0	7.5	0.41
00:24:00	21.0	59.5	10.8	0.75	00:49:00	46.0	40.5	6.7	0.33	00:24:00	21.0	46.0	7.9	0.45
00:25:00	22.0	58.0	10.5	0.72	00:51:00	48.0	43.0	7.3	0.38	00:25:00	22.0	48.0	8.3	0.49
00:26:00	23.0	60.0	10.9	0.77	00:53:00	50.0	45.0	7.7	0.43	00:26:00	23.0	46.0	7.9	0.45
00:27:00	24.0	57.0	10.3	0.70	00:55:00	52.0	45.0	7.7	0.43	00:27:00	24.0	46.5	8.0	0.46
00:28:00	25.0	59.0	10.7	0.74	00:57:00	54.0	46.0	7.9	0.45	00:28:00	25.0	48.0	8.3	0.49
00:29:00	26.0	60.0	10.9	0.77	00:59:00	56.0	47.0	8.1	0.47	00:29:00	26.0	48.5	8.4	0.50
00:30:00	27.0	61.0	11.2	0.79	01:01:00	58.0	48.0	8.3	0.49	00:30:00	27.0	47.0	8.1	0.47
00:31:00	28.0	59.0	10.7	0.74	01:03:00	60.0	50.5	8.9	0.55	00:31:00	28.0	49.0	8.5	0.51
00:32:00	29.0	61.0	11.2	0.79	01:05:00	62.0	50.5	8.9	0.55	00:32:00	29.0	48.5	8.4	0.50
00:33:00	30.0	60.0	10.9	0.77	01:07:00	64.0	51.0	9.0	0.56	00:33:00	30.0	50.0	8.7	0.54
00:38:00	35.0	61.5	11.3	0.80	01:09:00	66.0	51.0	9.0	0.56	00:38:00	35.0	53.0	9.4	0.60
00:43:00	40.0	66.0	12.2	0.90	01:14:00	71.0	56.0	10.1	0.67	00:43:00	40.0	56.5	9.7	0.63
00:48:00	45.0	67.5	12.6	0.93	01:19:00	76.0	55.0	9.9	0.65	00:48:00	45.0	61.0	11.0	0.77
00:53:00	50.0	67.0	12.5	0.92	01:24:00	81.0	56.5	10.2	0.69	00:53:00	50.0	58.0	10.4	0.71
00:58:00	55.0	68.0	12.7	0.94	01:29:00	86.0	59.0	10.7	0.74	00:58:00	55.0	59.0	10.6	0.73
01:03:00	60.0	68.5	12.8	0.96	01:35:41	92.7	61.0	11.2	0.79	01:03:00	60.0	59.5	10.7	0.74
01:18:00	75.0	70.0	13.1	0.99	01:40:00	97.0	61.0	11.2	0.79	01:18:00	75.0	64.0	11.6	0.84
01:33:00	90.0	70.5	13.2	1.00	01:46:00	103.0	63.0	11.6	0.83	01:33:00	90.0	68.0	12.5	0.92
01:48:00	105.0	69.0	12.9	0.97	01:51:00	108.0	63.0	11.6	0.83	01:48:00	105.0	69.0	12.7	0.95
02:03:00	120.0	70.5	13.2	1.00	01:56:00	113.0	65.0	12.0	0.88	02:03:00	120.0	70.0	12.9	0.97
02:30:00	147.0	70.5	13.2	1.00	02:04:35	121.6	65.0	12.0	0.88	02:18:00	135.0	70.5	13.0	0.98
03:00:00	177.0	70.5	13.2	1.00	02:17:00	134.0	67.0	12.4	0.92	02:33:00	150.0	71.0	13.1	0.99
					02:32:00	149.0	70.0	13.1	0.99	02:48:00	165.0	71.5	13.2	1.00
					02:47:00	164.0	70.0	13.1	0.99	03:03:00	180.0	71.5	13.2	1.00
					03:04:00	181.0	71.0	13.3	1.01					

0.2
-2.0

0.2
-1.7

0.2
-1.5

0.2
-1.6

0.2
-1.4

Point #2					Point #3							Point #4		
Time		Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co
min	min		mg/L		min	min		mg/L		min	min		mg/L	
00:03:00	0.0	25.0	3.6	0.00	00:03:00	0.0	25.0	3.6	0.00	00:03:30	0.5	24.5	3.6	0.01
00:04:00	1.0	25.0	3.6	0.00	00:04:00	1.0	25.0	3.6	0.00	00:04:30	1.5	24.0	3.5	-0.01
00:05:00	2.0	42.5	7.2	0.37	00:05:00	2.0	25.0	3.6	0.00	00:05:30	2.5	24.5	3.6	0.01
00:06:00	3.0	43.0	7.3	0.38	00:06:00	3.0	27.5	4.1	0.05	00:06:30	3.5	24.0	3.5	-0.01
00:07:00	4.0	46.5	8.0	0.46	00:07:00	4.0	28.0	4.2	0.06	00:07:30	4.5	25.0	3.7	0.02
00:08:00	5.0	53.5	9.4	0.61	00:08:00	5.0	29.0	4.4	0.09	00:08:30	5.5	27.5	4.3	0.07
00:09:00	6.0	56.0	9.7	0.64	00:09:00	6.0	33.0	5.2	0.17	00:09:30	6.5	28.5	4.5	0.09
00:10:00	7.0	58.0	10.3	0.70	00:10:00	7.0	33.0	5.2	0.17	00:10:30	7.5	31.0	5.0	0.15
00:11:00	8.0	56.0	9.7	0.64	00:11:00	8.0	36.0	5.8	0.24	00:11:30	8.5	34.0	5.6	0.21
00:12:00	9.0	56.0	9.9	0.66	00:12:00	9.0	40.0	6.7	0.32	00:12:30	9.5	34.5	5.7	0.22
00:13:00	10.0	58.5	10.4	0.71	00:13:00	10.0	40.0	6.7	0.32	00:13:30	10.5	38.0	6.4	0.30
00:14:00	11.0	59.0	10.5	0.72	00:14:00	11.0	42.0	7.1	0.37	00:14:30	11.5	35.5	5.9	0.24
00:15:00	12.0	61.0	11.0	0.77	00:15:00	12.0	46.0	7.9	0.45	00:15:30	12.5	36.5	6.1	0.26
00:16:00	13.0	59.5	10.6	0.73	00:16:00	13.0	43.0	7.3	0.39	00:16:30	13.5	37.0	6.2	0.27
00:17:00	14.0	59.0	10.5	0.72	00:17:00	14.0	44.5	7.6	0.42	00:17:30	14.5	38.0	6.4	0.30
00:18:00	15.0	61.0	11.0	0.77	00:18:00	15.0	45.0	7.7	0.43	00:18:30	15.5	38.5	6.5	0.31
00:19:00	16.0	61.0	11.0	0.77	00:19:00	16.0	47.0	8.1	0.47	00:19:30	16.5	41.0	7.1	0.36
00:20:00	17.0	62.0	11.2	0.79	00:20:00	17.0	50.0	8.8	0.54	00:20:30	17.5	39.5	6.7	0.33
00:21:00	18.0	59.0	10.5	0.72	00:21:00	18.0	47.5	8.2	0.48	00:21:30	18.5	43.0	7.5	0.40
00:22:00	19.0	63.0	11.4	0.81	00:22:00	19.0	49.0	8.6	0.52	00:22:30	19.5	42.0	7.3	0.38
00:23:00	20.0	62.0	11.2	0.79	00:23:00	20.0	49.0	8.6	0.52	00:23:30	20.5	44.0	7.7	0.42
00:24:00	21.0	61.0	11.0	0.77	00:24:00	21.0	50.5	8.9	0.55	00:24:30	21.5	42.0	7.3	0.38
00:25:00	22.0	63.0	11.4	0.81	00:25:00	22.0	51.0	9.0	0.56	00:25:30	22.5	43.5	7.6	0.41
00:26:00	23.0	62.0	11.2	0.79	00:26:00	23.0	51.0	9.0	0.56	00:26:30	23.5	45.0	7.9	0.45
00:27:00	24.0	63.0	11.4	0.81	00:27:00	24.0	52.0	9.2	0.58	00:27:30	24.5	47.5	8.4	0.50
00:28:00	25.0	62.0	11.2	0.79	00:28:00	25.0	52.5	9.3	0.59	00:28:30	25.5	49.5	8.8	0.54
00:29:00	26.0	63.0	11.4	0.81	00:29:00	26.0	52.0	9.2	0.58	00:29:30	26.5	49.5	8.8	0.54
00:30:00	27.0	63.0	11.4	0.81	00:30:00	27.0	51.0	9.0	0.56	00:30:30	27.5	50.0	8.9	0.55
00:31:00	28.0	63.0	11.4	0.81	00:31:00	28.0	52.0	9.2	0.58	00:31:30	28.5	51.0	9.1	0.58
00:32:00	29.0	63.0	11.4	0.81	00:32:00	29.0	52.0	9.2	0.58	00:32:30	29.5	52.0	9.3	0.60
00:33:00	30.0	61.5	11.1	0.78	00:33:00	30.0	53.0	9.4	0.60	00:33:30	30.5	52.0	9.3	0.60
00:38:00	35.0	66.0	12.0	0.87	00:38:00	35.0	53.5	9.5	0.61	00:38:30	35.5	53.0	9.5	0.62
00:43:00	40.0	68.0	12.4	0.91	00:43:00	40.0	55.0	9.8	0.65	00:43:30	40.5	54.0	9.7	0.64
00:48:00	45.0	68.5	12.5	0.93	00:48:00	45.0	57.5	10.3	0.70	00:48:30	45.5	54.0	9.7	0.64
00:53:00	50.0	68.5	12.5	0.93	00:53:00	50.0	58.0	10.4	0.71	00:53:30	50.5	58.0	10.6	0.73
00:58:00	55.0	68.5	12.1	0.88	00:58:00	55.0	61.0	11.0	0.77	00:58:30	55.5	59.0	10.8	0.75
01:03:00	60.0	66.0	12.0	0.87	01:03:00	60.0	63.0	11.4	0.82	01:03:30	60.5	60.5	11.1	0.78
01:18:00	75.0	69.5	12.7	0.95	01:18:00	75.0	65.0	11.9	0.86	01:18:30	75.5	64.0	11.8	0.85
01:33:00	90.0	70.5	12.9	0.97	01:33:00	90.0	67.0	12.3	0.90	01:33:30	90.5	65.0	12.0	0.88
01:48:00	105.0	71.0	13.0	0.98	01:48:00	105.0	68.5	12.6	0.94	01:48:30	105.5	68.0	12.6	0.94
02:03:00	120.0	71.0	13.0	0.98	02:03:00	120.0	70.0	12.9	0.97	02:03:30	120.5	68.0	12.6	0.94
02:18:00	135.0	72.0	13.2	1.00	02:18:00	135.0	70.5	13.0	0.98	02:18:30	135.5	68.0	12.6	0.94
02:33:00	150.0	72.0	13.2	1.00	02:33:00	150.0	71.0	13.1	0.99	02:33:30	150.5	69.0	12.8	0.96
02:48:00	165.0	72.0	13.2	1.00	02:48:00	165.0	71.5	13.2	1.00	02:48:30	165.5	71.0	13.3	1.01
03:03:00	180.0	76.5	14.1	1.10	03:03:00	180.0	71.5	13.2	1.00	03:03:30	180.5	70.5	13.1	0.99

SAMPLING NO:	**4**	
LOCATION:	**Reservoir 1**	
FLOW (ML/d):	180	
SAMPLING DATE:	24-Mar-93	
TESTING DATE:	30-Mar-93	(omit these data)
	09-Apr-93	(use these data)
STANDARD MADE:	22-Feb-93	(old standard)
	09-Apr-93	(new standrad)

STANDARDIZATION

mg/L Na	Initial Reading	Initial Reading	Average
2.5	18.5	17.5	18.0
5.0	35.0	34.5	34.8
10.0	61.5	60.5	61.0
15.0	83.0	81.5	82.3
17.5	91.0	91.0	91.0
20.0	100.0	98.0	99.0

Regression Statistics

Multiple R	0.995
R Square	0.989
Adjusted R Square	0.986
Standard Error	0.819
Observations	6

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	243.152	243.152	362.681	0.000
Residual	4	2.682	0.670		
Total	5	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.156	0.799	-2.698	0.043	-4.375	0.063
x1	0.215	0.011	19.044	0.000	0.184	0.246

General Equation: y=0.215x-2.156

TEST NO. 4
RESERVOIR NO. 1 (180 ML/d)

NaBack(mg/L)=	4.04	m=	0.2	m=	0.2
NaFinal(mg/L)=	16.72	b=	-2.2	b=	-1.6
NaTracer(mg/L)=	12.68				

Inlet						Outlet					
Time		t/Td	Reading	Conc. Na	C/Co	Time		t/Td	Reading	Conc. Na	C/Co
min	min	Td=297		mg/L		min	min	Td=297		mg/L	
00:05:00	0.0	0.00	28.5	4.0	-0.01	00:05:00	0.0	0.00	27.0	4.0	0.00
00:06:00	1.0	0.00	28.5	4.0	-0.01	00:15:00	10.0	0.03	27.0	4.0	0.00
00:07:00	2.0	0.01	29.5	4.2	0.01	00:25:00	20.0	0.07	27.0	4.0	0.00
00:08:00	3.0	0.01	28.0	3.9	-0.01	00:35:00	30.0	0.10	27.0	4.0	0.00
00:09:00	4.0	0.01	29.0	4.1	0.00	00:45:00	40.0	0.13	27.0	4.0	0.00
00:10:00	5.0	0.02	28.5	4.0	-0.01	00:55:00	50.0	0.17	27.0	4.0	0.00
00:11:00	6.0	0.02	29.0	4.1	0.00	01:00:00	55.0	0.19	28.0	4.3	0.02
00:12:00	7.0	0.02	29.0	4.1	0.00	01:05:00	60.0	0.20	27.0	4.0	0.00
00:13:00	8.0	0.03	29.0	4.1	0.00	01:10:00	65.0	0.22	27.5	4.1	0.01
00:14:00	9.0	0.03	28.5	4.0	-0.01	01:15:00	70.0	0.24	28.0	4.3	0.02
00:15:00	10.0	0.03	28.5	4.0	-0.01	01:25:00	80.0	0.27	28.0	4.3	0.02
00:16:00	11.0	0.04	30.5	4.4	0.03	01:35:00	90.0	0.30	31.0	4.9	0.07
00:17:00	12.0	0.04	29.5	4.2	0.01	01:40:00	95.0	0.32	33.5	5.4	0.11
00:18:00	13.0	0.04	29.0	4.1	0.00	01:45:00	100.0	0.34	36.0	5.9	0.15
00:19:00	14.0	0.05	29.5	4.2	0.01	01:55:00	110.0	0.37	40.5	6.9	0.22
00:20:00	15.0	0.05	30.5	4.4	0.03	02:05:00	120.0	0.40	43.5	7.5	0.27
00:21:00	16.0	0.05	38.0	6.0	0.16	02:15:00	130.0	0.44	48.0	8.4	0.35
00:22:00	17.0	0.06	43.0	7.1	0.24	02:25:00	140.0	0.47	47.5	8.3	0.34
00:23:00	18.0	0.06	50.5	8.7	0.37	02:35:00	150.0	0.51	50.5	8.9	0.39
00:24:00	19.0	0.06	55.5	9.8	0.45	02:45:00	160.0	0.54	55.5	10.0	0.47
00:25:00	20.0	0.07	61.0	11.0	0.55	02:55:00	170.0	0.57	54.5	9.8	0.45
00:26:00	21.0	0.07	69.5	12.8	0.69	03:05:00	180.0	0.61	57.0	10.3	0.49
00:27:00	22.0	0.07	66.0	12.0	0.63	03:15:00	190.0	0.64	57.5	10.4	0.50
00:28:00	23.0	0.08	65.5	11.9	0.62	03:25:00	200.0	0.67	61.0	11.1	0.56
00:29:00	24.0	0.08	66.0	12.0	0.63	03:38:00	213.0	0.72	63.0	11.5	0.59
00:30:00	25.0	0.08	70.0	12.9	0.70	03:45:00	220.0	0.74	62.5	11.4	0.58
00:31:00	26.0	0.09	71.0	13.1	0.71	03:55:00	230.0	0.77	63.0	11.5	0.59
00:32:00	27.0	0.09	73.0	13.5	0.75	04:05:00	240.0	0.81	63.5	11.7	0.60
00:33:00	28.0	0.09	75.0	14.0	0.78	04:15:00	250.0	0.84	65.0	12.0	0.62
00:34:00	29.0	0.10	79.0	14.8	0.85	04:25:00	260.0	0.88	65.5	12.1	0.63
00:35:00	30.0	0.10	78.5	14.7	0.84	04:35:00	270.0	0.91	66.5	12.3	0.65
00:40:00	35.0	0.12	85.0	16.1	0.95	04:45:00	280.0	0.94	67.0	12.4	0.66
00:45:00	40.0	0.13	84.0	15.9	0.94	04:55:00	290.0	0.98	71.0	13.2	0.72
00:50:00	45.0	0.15	85.5	16.2	0.96	05:05:00	300.0	1.01	71.0	13.2	0.72
00:58:23	53.4	0.18	84.5	16.0	0.94	05:15:00	310.0	1.04	72.0	13.4	0.74
01:01:40	56.7	0.19	90.0	17.2	1.04	05:25:00	320.0	1.08	73.0	13.6	0.76
01:06:00	61.0	0.21	84.5	16.0	0.94	05:35:00	330.0	1.11	74.5	13.9	0.78
01:10:00	65.0	0.22	90.5	17.3	1.05	05:45:00	340.0	1.14	75.0	14.1	0.79
02:12:00	127.0	0.43	87.5	16.7	0.99	05:55:00	350.0	1.18	75.5	14.2	0.80
03:05:00	180.0	0.61	88.0	16.8	1.00	06:05:00	360.0	1.21	73.0	13.6	0.76
04:05:00	240.0	0.81	87.0	16.5	0.99	06:15:00	370.0	1.25	74.5	13.9	0.78
05:05:00	300.0	1.01	84.0	15.9	0.94	06:25:00	380.0	1.28	76.0	14.3	0.81
06:05:00	360.0	1.21	83.5	15.8	0.93	06:35:00	390.0	1.31	76.5	14.4	0.81
07:05:00	420.0	1.41	85.5	16.2	0.96	06:45:00	400.0	1.35	78.5	14.8	0.85
08:05:00	480.0	1.62	90.5	17.3	1.05	06:55:00	410.0	1.38	79.0	14.9	0.86
09:05:00	540.0	1.82	91.0	17.4	1.05	07:05:00	420.0	1.41	80.0	15.1	0.87
10:05:00	600.0	2.02	94.5	18.2	1.11	07:19:00	434.0	1.46	79.0	14.9	0.86
11:05:00	660.0	2.22	91.5	17.5	1.06	07:25:00	440.0	1.48	80.0	15.1	0.87
12:05:00	720.0	2.42	97.0	18.7	1.16	07:35:00	450.0	1.52	80.5	15.2	0.88
						07:55:00	470.0	1.58	80.5	15.2	0.88
						08:05:00	480.0	1.62	81.0	15.3	0.89
						08:15:00	490.0	1.65	80.0	15.1	0.87
						08:25:00	500.0	1.68	80.0	15.1	0.87
						08:35:00	510.0	1.72	81.0	15.3	0.89
						08:45:00	520.0	1.75	81.0	15.3	0.89
						08:55:00	530.0	1.78	82.5	15.6	0.91
						09:05:00	540.0	1.82	82.0	15.5	0.90
						09:15:00	550.0	1.85	83.5	15.8	0.93
						09:25:00	560.0	1.89	84.0	15.9	0.94
						09:35:00	570.0	1.92	84.5	16.0	0.95
						09:45:00	580.0	1.95	83.5	15.8	0.93
						09:55:00	590.0	1.99	85.0	16.1	0.95
						10:05:00	600.0	2.02	85.0	16.1	0.95
						10:15:00	610.0	2.05	85.0	16.1	0.95
						10:25:00	620.0	2.09	85.0	16.1	0.95
						10:35:00	630.0	2.12	85.0	16.1	0.95
						10:45:00	640.0	2.15	85.0	16.1	0.95
						10:55:00	650.0	2.19	86.5	16.5	0.98
						11:05:00	660.0	2.22	86.5	16.5	0.98
						11:15:00	670.0	2.26	90.0	17.2	1.04
						11:25:00	680.0	2.29	88.5	16.9	1.01
						11:35:00	690.0	2.32	88.5	16.9	1.01
						11:45:00	700.0	2.36	88.5	16.9	1.01

11:55:00	710.0	2.39	87.5	16.7	0.99
12:05:00	720.0	2.42	87.5	16.7	0.99
12:15:00	730.0	2.46	86.5	16.5	0.98
12:25:00	740.0	2.49	88.0	16.8	1.00
12:35:00	750.0	2.53	87.5	16.7	0.99

Grvt Eqn: y=0.215x-2.156

	(INLET)	(OUTLET)	
Na start:	4.04	3.65	
Na finish:	16.72	16.72	
Initial:	28.8	27.0	(aveerge of 3 first samples)
Steady:	87.8	87.5	(average of 8 last samples from OUTLET)
			(assumed Steady for Inlet = Outlet)

m= 0.2
b= -2.2

System			Time Correction		Background					
Time In	TOut-Tin	T/Td			Time		t/Td	Reading	Conc. Na	C/Co
Equi.	min	Td=297	C/Co	Time(min)	min	min	Td=297		mg/L	
14.0	0.0	0.00	0.00	14.0	00:05:00	0.0	0.00	27.5	3.8	0.0
14.0	0.0	0.00	0.05	15.0	02:05:00	120.0	0.40	27.5	3.8	0.0
14.0	6.0	0.02	0.10	15.5	04:05:00	240.0	0.81	27.5	3.8	0.0
14.0	16.0	0.05	0.15	16.0	06:05:00	360.0	1.21	27.5	3.8	0.0
14.0	26.0	0.09	0.20	16.5	08:05:00	480.0	1.62	31.0	4.5	0.0
14.0	36.0	0.12	0.25	17.0	10:05:00	600.0	2.02	36.5	5.7	0.1
14.3	40.7	0.14	0.30	17.5						
14.0	46.0	0.15	0.35	18.0						
14.2	50.8	0.17	0.40	18.5						
14.3	55.7	0.19	0.45	19.0						
14.3	65.7	0.22	0.50	19.5						
15.2	74.8	0.25	0.55	20.0						
15.6	79.4	0.27	0.60	20.5						
16.0	84.0	0.28	0.65	22.0						
16.7	93.3	0.31	0.70	25.0						
17.2	102.8	0.35	0.75	27.0						
18.0	112.0	0.38	0.80	28.0						
17.9	122.1	0.41	0.85	29.0						
18.4	131.6	0.44	0.90	33.0						
19.2	140.8	0.47	0.95	35.0						
19.0	151.0	0.51	1.00	55.0						
19.4	160.6	0.54								
19.5	170.5	0.57								
20.1	179.9	0.61								
20.4	192.6	0.65								
20.3	199.7	0.67								
20.4	209.6	0.71								
20.5	219.5	0.74								
21.2	228.8	0.77								
21.5	238.5	0.80								
22.0	248.0	0.84								
22.5	257.5	0.87								
25.9	264.1	0.89								
25.9	274.1	0.92								
26.6	283.4	0.95								
27.1	292.9	0.99								
27.6	302.4	1.02								
27.8	312.2	1.05								
28.0	322.0	1.08								
27.1	332.9	1.12								
27.6	342.4	1.15								
28.1	351.9	1.18								
28.3	361.7	1.22								
28.9	371.1	1.25								
29.4	380.6	1.28								
30.7	389.3	1.31								
29.4	404.6	1.36								
30.7	409.3	1.38								
31.4	418.6	1.41								
31.4	438.6	1.48								
32.0	448.0	1.51								
30.7	459.3	1.55								
30.7	469.3	1.58								
32.0	478.0	1.61								
32.0	488.0	1.64								
33.5	496.5	1.67								
33.2	506.8	1.71								
34.2	515.8	1.74								
34.5	525.5	1.77								
34.8	535.2	1.80								
34.2	545.8	1.84								
36.5	553.5	1.86								
36.5	563.5	1.90								
36.5	573.5	1.93								
36.5	583.5	1.96								
36.5	593.5	2.00								
36.5	603.5	2.03								
46.4	603.6	2.03								
46.4	613.6	2.07								
55.0	615.0	2.07								
55.0	625.0	2.10								
55.0	635.0	2.14								
55.0	645.0	2.17								

52.9	657.1	2.21
52.9	667.1	2.25
46.4	683.6	2.30
55.0	685.0	2.31
52.9	697.1	2.35

SAMPLING NO:	**5**
LOCATION:	**Reservoir 2**
FLOW (ML/d):	187
SAMPLING DATE:	06-Apr-93
TESTING DATE:	09-Apr-93
STANDARD MADE:	09-Apr-93

STANDARDIZATION

mg/L Na	Initial Reading	Final Reading	Average
2.5	18.5	18.5	18.5
5.0	35.0	35.0	35.0
10.0	61.5	61.5	61.5
15.0	83.0	83.0	83.0
17.5	91.0	91.0	91.0
20.0	100.0	100.0	100.0

Regression Statistics

Multiple R	0.995
R Square	0.990
Adjusted R Square	0.987
Standard Error	0.800
Observations	6

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	243.270	243.270	379.677	0.000
Residual	4	2.563	0.641		
Total	5	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.224	0.784	-2.836	0.036	-4.402	-0.047
x1	0.214	0.011	19.485	0.000	0.184	0.245

General Equation: y=0.214x-2.224

TEST NO. 5
RESERVOIR NO.2 (167 ML/d)

NaBack(mg/L)=	4.87	m=	0.2	m=	0.2
NaFirst(mg/L)=	17.36	b=	-2.2	b=	-2.1
NaTracer(mg/L)=	12.48				

Inlet						Outlet					
Time		t/Td	Reading	Conc. Na	C/Co	Time		t/Td	Reading	Conc. Na	C/Co
min	min	Td=276		mg/L	Data	min	min	Td=276		mg/L	Data
00:05:00	0.0	0.00	33.0	4.8	0.00	-	0.0	0.00	-	-	0.00
00:06:00	1.0	0.00	33.5	4.9	0.01	00:10:00	5.0	0.02	32.5	4.9	0.00
00:07:00	2.0	0.01	33.0	4.8	0.00	00:20:00	15.0	0.05	32.5	4.9	0.00
00:08:00	3.0	0.01	33.0	4.8	0.00	00:30:00	25.0	0.09	32.5	4.9	0.00
00:09:00	4.0	0.01	33.0	4.8	0.00	00:40:00	35.0	0.13	42.0	6.9	0.16
00:10:00	5.0	0.02	33.0	4.8	0.00	00:50:00	45.0	0.16	45.5	7.7	0.22
00:11:00	6.0	0.02	33.0	4.8	0.00	01:00:00	55.0	0.20	50.5	8.7	0.31
00:12:00	7.0	0.03	33.0	4.8	0.00	01:10:00	65.0	0.24	52.0	9.0	0.33
00:13:00	8.0	0.03	33.0	4.8	0.00	01:20:00	75.0	0.27	52.5	9.2	0.34
00:14:00	9.0	0.03	32.5	4.7	-0.01	01:30:00	85.0	0.31	56.5	10.0	0.41
00:15:00	10.0	0.04	33.5	4.9	0.01	01:40:00	95.0	0.34	59.5	10.7	0.46
00:16:00	11.0	0.04	33.0	4.8	0.00	01:50:00	105.0	0.38	60.0	10.8	0.47
00:17:00	12.0	0.04	32.0	4.6	-0.02	02:00:00	115.0	0.42	59.0	10.5	0.45
00:18:00	13.0	0.05	32.5	4.7	-0.01	02:10:00	125.0	0.45	61.0	11.0	0.49
00:19:00	14.0	0.05	32.5	4.7	-0.01	02:20:00	135.0	0.49	61.5	11.1	0.50
00:20:00	15.0	0.05	32.5	4.7	-0.01	02:30:00	145.0	0.53	64.0	11.6	0.54
00:21:00	16.0	0.06	33.0	4.8	0.00	02:40:00	155.0	0.56	62.0	11.2	0.51
00:22:00	17.0	0.06	33.0	4.8	0.00	02:50:00	165.0	0.60	64.5	11.7	0.55
00:23:00	18.0	0.07	33.5	4.9	0.01	03:00:00	175.0	0.63	67.5	12.4	0.60
00:24:00	19.0	0.07	34.0	5.1	0.01	03:13:30	188.5	0.68	67.5	12.4	0.60
00:25:00	20.0	0.07	33.5	4.9	0.01	03:20:00	195.0	0.71	68.0	12.5	0.61
00:26:00	21.0	0.08	34.0	5.1	0.01	03:30:00	205.0	0.74	69.0	12.7	0.63
00:27:00	22.0	0.08	35.0	5.3	0.03	03:40:00	215.0	0.78	71.0	13.1	0.66
00:28:00	23.0	0.08	39.0	6.1	0.10	03:50:00	225.0	0.82	74.0	13.8	0.71
00:29:00	24.0	0.09	44.0	7.2	0.19	04:00:00	235.0	0.85	73.0	13.5	0.69
00:30:00	25.0	0.09	46.5	7.7	0.23	04:10:00	245.0	0.89	73.0	13.5	0.69
00:31:00	26.0	0.09	59.5	10.5	0.45	04:20:00	255.0	0.92	73.0	13.5	0.69
00:32:00	27.0	0.10	68.5	12.4	0.61	04:30:00	265.0	0.96	73.0	13.5	0.69
00:33:00	28.0	0.10	74.5	13.7	0.71	04:40:00	275.0	1.00	73.0	13.5	0.69
00:34:00	29.0	0.11	79.0	14.7	0.79	04:50:00	285.0	1.03	75.0	14.0	0.73
00:35:00	30.0	0.11	79.0	14.7	0.79	05:00:00	295.0	1.07	75.5	14.1	0.74
00:40:00	35.0	0.13	87.0	16.4	0.92	05:10:00	305.0	1.11	77.5	14.5	0.77
00:45:00	40.0	0.14	90.0	17.0	0.97	05:20:00	315.0	1.14	77.5	14.5	0.77
00:50:00	45.0	0.16	91.0	17.3	0.99	05:30:00	325.0	1.18	78.0	14.6	0.78
00:55:45	50.8	0.18	90.5	17.1	0.98	05:40:00	335.0	1.21	79.0	14.8	0.80
01:00:00	55.0	0.20	93.0	17.7	1.03	05:50:00	345.0	1.25	81.0	15.3	0.83
01:06:00	61.0	0.22	93.0	17.7	1.03	06:03:00	358.0	1.30	81.0	15.3	0.83
01:10:00	65.0	0.24	92.5	17.6	1.02	06:14:30	369.5	1.34	81.5	15.4	0.84
01:15:00	70.0	0.25	91.0	17.3	0.99	06:22:00	377.0	1.37	81.5	15.4	0.84
01:20:00	75.0	0.27	91.5	17.4	1.00	06:31:30	386.5	1.40	80.0	15.0	0.81
01:25:00	80.0	0.29	89.5	16.9	0.97	06:40:00	395.0	1.43	81.0	15.3	0.83
01:30:00	85.0	0.31	90.0	17.0	0.97	06:50:00	405.0	1.47	81.0	15.3	0.83
02:00:00	115.0	0.42	90.5	17.1	0.98	07:00:00	415.0	1.50	81.5	15.4	0.84
03:00:00	175.0	0.63	88.5	16.7	0.95	07:11:30	426.5	1.55	81.5	15.4	0.84
04:00:00	235.0	0.85	91.0	17.3	0.99	07:20:00	435.0	1.58	81.5	15.4	0.84
05:00:00	295.0	1.07	89.5	16.9	0.97	07:30:00	445.0	1.61	83.0	15.7	0.87
06:00:00	355.0	1.29	91.0	17.3	0.99	07:40:00	455.0	1.65	83.0	15.7	0.87
07:00:00	415.0	1.50	90.5	17.1	0.98	07:50:00	465.0	1.68	83.0	15.7	0.87
08:00:00	475.0	1.72	91.5	17.4	1.00	08:01:30	476.5	1.73	84.5	16.0	0.89
09:00:00	535.0	1.94	91.0	17.3	0.99	08:11:00	486.0	1.76	85.0	16.1	0.90
09:54:30	589.5	2.14	91.0	17.3	0.99	08:20:00	495.0	1.79	86.0	16.3	0.92
10:54:30	649.5	2.35	92.5	17.6	1.02	08:30:00	505.0	1.83	84.0	15.9	0.88
11:54:00	709.0	2.57	92.0	17.5	1.01	08:42:30	517.5	1.88	84.0	15.9	0.88
13:00:00	775.0	2.81	91.0	17.3	0.99	08:50:00	525.0	1.90	85.0	16.1	0.90
14:00:00	835.0	3.03	91.5	17.4	1.00	09:00:00	535.0	1.94	85.5	16.2	0.91
						09:13:00	548.0	1.99	85.0	16.1	0.90
						09:20:00	555.0	2.01	85.0	16.1	0.90
						09:30:00	565.0	2.05	85.5	16.2	0.91
						09:40:00	575.0	2.08	87.0	16.5	0.93
						09:50:00	585.0	2.12	87.0	16.5	0.93
						10:00:00	595.0	2.16	87.5	16.6	0.94
						10:12:00	607.0	2.20	88.5	16.9	0.96
						10:20:00	615.0	2.23	88.0	16.8	0.95
						10:30:00	625.0	2.26	89.0	17.0	0.97
						10:40:00	635.0	2.30	88.0	16.8	0.95
						10:50:00	645.0	2.34	88.0	16.8	0.95
						11:03:00	658.0	2.38	86.5	16.4	0.93
						11:10:00	665.0	2.41	88.0	16.8	0.95
						11:20:00	675.0	2.45	88.0	16.8	0.95
						11:30:00	685.0	2.48	89.0	17.0	0.97
						11:40:00	695.0	2.52	90.0	17.2	0.99
						11:50:00	705.0	2.55	90.0	17.2	0.99
						12:00:00	715.0	2.59	90.5	17.3	0.99

12:10:00	725.0	2.63	90.5	17.3	0.99
12:20:00	735.0	2.66	90.0	17.2	0.99
12:30:00	745.0	2.70	90.0	17.2	0.99
12:40:00	755.0	2.74	90.5	17.3	0.99
12:50:00	765.0	2.77	89.0	17.0	0.97
13:00:00	775.0	2.81	88.5	16.9	0.96
13:10:00	785.0	2.84	88.5	16.9	0.96
13:20:00	795.0	2.88	88.5	16.9	0.96
13:30:00	805.0	2.92	88.0	16.8	0.95
13:40:00	815.0	2.95	89.0	17.0	0.97
13:50:00	825.0	2.99	89.0	17.0	0.97
14:00:00	835.0	3.03	90.0	17.2	0.99
14:10:00	845.0	3.06	90.5	17.3	0.99
14:20:00	855.0	3.10	90.5	17.3	0.99
14:30:00	865.0	3.13	90.0	17.2	0.99
14:40:00	875.0	3.17	90.5	17.3	0.99
14:50:00	885.0	3.21	91.0	17.4	1.00
15:00:00	895.0	3.24	91.0	17.4	1.00

Grnl Eqn: y=0.214x-2.224

	(INLET)	(OUTLET)	
Na start:	4.87	4.73	
Na finish:	17.36	17.21	
Initial	33.2	32.5	(average of 3 first samples)
Steady	91.5	90.8	(average of 3 last samples)

m= 0.2
b= -2.2

Bytrm					Background					
Time In	TOut-TIn	T/Td	Time Correction		Time		t/Td	Reading	Conc. Na	C/Co
Eqvl.	min.	Td=276	C/Co	Time(min)	min	min	Td=276		mg/L	
20.0	0.0	0.00	0.00	20.0	00:05:00	0.0	0.00	32.5	4.7	-0.01
20.0	0.0	0.00	0.05	22.0	01:45:00	100.0	0.36	32.5	4.7	-0.01
20.0	0.0	0.00	0.10	23.0	03:00:00	175.0	0.63	32.5	4.7	-0.01
20.0	5.0	0.02	0.15	23.5	04:00:00	235.0	0.85	33.0	4.8	0.00
23.4	11.4	0.04	0.20	24.0	05:00:00	295.0	1.07	33.0	4.8	0.00
24.2	20.8	0.08	0.25	24.5	06:00:00	355.0	1.29	33.5	4.9	0.01
25.1	29.9	0.11	0.30	25.0	07:00:00	415.0	1.50	34.0	5.1	0.01
25.3	39.7	0.14	0.35	25.5	09:00:00	535.0	1.94	33.5	4.9	0.01
25.4	49.6	0.18	0.40	26.0	10:00:00	595.0	2.16	33.5	4.9	0.01
26.0	59.0	0.21	0.45	26.0	11:00:00	655.0	2.37	34.0	5.1	0.01
26.1	68.9	0.25	0.50	26.5	12:00:00	715.0	2.59	33.5	4.9	0.01
26.2	78.8	0.29	0.55	26.5	13:00:00	775.0	2.81	33.5	4.9	0.01
26.0	89.0	0.32	0.60	27.0	14:00:00	835.0	3.03	33.5	4.9	0.01
26.4	98.6	0.36	0.65	27.5						
26.5	108.5	0.39	0.70	28.0						
26.5	118.5	0.43	0.75	28.5						
26.5	128.5	0.47	0.80	30.0						
26.5	138.5	0.50	0.85	32.0						
27.0	148.0	0.54	0.90	34.0						
27.0	161.5	0.59	0.95	37.5						
27.1	167.9	0.61	1.00	45.0						
27.3	177.7	0.64								
27.6	187.4	0.68								
28.1	196.9	0.71								
27.9	207.1	0.75								
27.9	217.1	0.79								
27.9	227.1	0.82								
27.9	237.1	0.86								
27.9	247.1	0.90								
28.3	256.7	0.93								
28.4	266.6	0.97								
29.1	275.9	1.00								
29.1	285.9	1.04								
29.4	295.6	1.07								
29.9	305.1	1.11								
31.3	313.7	1.14								
31.3	326.7	1.18								
31.6	337.9	1.22								
31.6	345.4	1.25								
30.6	355.9	1.29								
31.3	363.7	1.32								
31.3	373.7	1.35								
31.6	383.4	1.39								
31.6	394.9	1.43								
31.6	403.4	1.46								
32.6	412.4	1.49								
32.6	422.4	1.53								
32.6	432.4	1.57								
33.7	442.8	1.60								
34.0	452.0	1.64								
35.2	459.8	1.67								
33.3	471.7	1.71								
33.3	484.2	1.75								
34.0	491.0	1.78								
34.6	500.4	1.81								
34.0	514.0	1.86								
34.0	521.0	1.89								
34.6	530.4	1.92								
36.4	538.6	1.95								
36.4	548.6	1.99								
37.0	558.0	2.02								
39.0	568.0	2.06								
37.7	577.3	2.09								
40.3	584.7	2.12								
37.7	597.3	2.16								
37.7	607.3	2.20								
35.8	622.2	2.25								
37.7	627.3	2.27								
37.7	637.3	2.31								
40.3	644.7	2.34								
42.9	652.1	2.36								
42.9	662.1	2.40								
44.1	670.9	2.43								

44.1	680.9	2.47
42.9	692.1	2.51
42.9	702.1	2.54
44.1	710.9	2.58
40.3	726.7	2.63
39.0	736.0	2.67
39.0	746.0	2.70
39.0	756.0	2.74
37.7	767.3	2.78
40.3	774.7	2.81
40.3	784.7	2.84
42.9	792.1	2.87
44.1	900.9	2.90
44.1	810.9	2.94
42.9	822.1	2.98
44.1	830.9	3.01
45.0	840.0	3.04
45.0	850.0	3.08

SAMPLING NO:	**6**
LOCATION:	**Reservoir 2**
FLOW (ML/d):	141
SAMPLING DATE:	20-Apr-93
TESTING DATE:	22-Apr-93
STANDARD MADE:	09-Apr-93

STANDARDIZATION

mg/L Na	Initial Reading	Final Reading	Average
2.5	17.5	17.5	17.5
5.0	32.5	32.5	32.5
10.0	58.5	58.0	58.3
15.0	80.5	80.0	80.3
17.5	89.5	89.0	89.3
20.0	100.0	98.0	99.0

Regression Statistics

Multiple R	0.997
R Square	0.995
Adjusted R Square	0.993
Standard Error	0.575
Observations	6

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	244.509	244.509	738.661	0.000
Residual	4	1.324	0.331		
Total	5	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.813	0.549	-3.304	0.021	-3.337	-0.290
x1	0.215	0.008	27.178	0.000	0.193	0.237

General Equation: $y=0.215x-1.813$

TEST NO. 6
RESERVOIR NO.2 (141 ML/d)

NaBack(mg/L)=	3.92	m=	0.2	m=	0.2
NaFinal(mg/L)=	18.00	b=	-1.8	b=	-2.0
NaTracer(mg/L)=	14.08				

Inlet						Outlet					
Time		t/Td	Reading	Conc. Na	C/Co	Time		t/Td	Reading	Conc. Na	C/Co
min	min	Td=292		mg/L	Data	min	min	Td=292		mg/L	Data
00:05:00	0.0	0.00	27.0	4.0	0.01	-	0.0	0.00	-	-	0.00
00:06:00	1.0	0.00	26.5	3.9	0.00	00:13:30	8.5	0.03	26.5	3.9	0.00
00:07:00	2.0	0.01	26.5	3.9	0.00	00:20:20	15.3	0.05	26.5	3.9	0.00
00:08:00	3.0	0.01	26.5	3.9	0.00	00:31:15	26.3	0.09	26.5	3.9	0.00
00:09:00	4.0	0.01	26.5	3.9	0.00	00:41:30	36.5	0.13	26.5	3.9	0.00
00:10:00	5.0	0.02	26.5	3.9	0.00	00:52:00	47.0	0.16	37.0	6.3	0.17
00:11:00	6.0	0.02	26.5	3.9	0.00	01:01:50	56.8	0.19	43.5	7.7	0.27
00:13:00	10.0	0.03	27.0	4.0	0.01	01:10:00	65.0	0.22	43.5	7.7	0.27
00:16:00	11.0	0.04	27.0	4.0	0.01	01:22:00	77.0	0.26	44.5	7.9	0.29
00:17:00	12.0	0.04	27.0	4.0	0.01	01:30:00	85.0	0.29	45.5	8.2	0.30
00:18:00	13.0	0.04	27.0	4.0	0.01	01:40:00	95.0	0.33	47.5	8.6	0.33
00:19:00	14.0	0.05	27.0	4.0	0.01	01:50:00	105.0	0.36	54.5	10.2	0.44
00:20:00	15.0	0.05	27.0	4.0	0.01	02:00:00	115.0	0.39	53.5	10.0	0.43
00:23:00	18.0	0.06	27.0	4.0	0.01	02:10:00	125.0	0.43	54.0	10.1	0.44
00:24:00	19.0	0.07	27.0	4.0	0.01	02:20:00	135.0	0.46	55.0	10.3	0.45
00:25:00	20.0	0.07	28.0	4.2	0.02	02:30:00	145.0	0.50	56.0	10.5	0.47
00:26:00	21.0	0.07	27.0	4.0	0.01	02:40:00	155.0	0.53	58.5	11.1	0.51
00:27:00	22.0	0.08	27.0	4.0	0.01	02:50:00	165.0	0.57	59.5	11.3	0.52
00:28:00	23.0	0.08	27.0	4.0	0.01	03:00:00	175.0	0.60	61.0	11.6	0.55
00:29:00	24.0	0.08	27.0	4.0	0.01	03:13:30	188.5	0.65	62.0	11.9	0.56
00:30:00	25.0	0.09	27.0	4.0	0.01	03:20:00	195.0	0.67	63.0	12.1	0.58
00:33:00	28.0	0.10	37.5	6.2	0.17	03:31:30	206.5	0.71	64.0	12.3	0.60
00:34:00	29.0	0.10	45.5	8.0	0.29	03:40:00	215.0	0.74	64.5	12.4	0.60
00:35:00	30.0	0.10	49.0	8.7	0.34	03:50:00	225.0	0.77	65.0	12.5	0.61
00:40:00	35.0	0.12	76.0	14.5	0.75	04:00:00	235.0	0.80	66.0	12.7	0.63
00:45:00	40.0	0.14	86.0	16.7	0.91	04:10:00	245.0	0.84	66.0	12.7	0.63
00:50:00	45.0	0.15	91.0	17.8	0.98	04:20:00	255.0	0.87	67.5	13.1	0.65
00:55:45	50.8	0.17	92.5	18.1	1.01	04:30:00	265.0	0.91	67.5	13.1	0.65
01:00:00	55.0	0.19	93.5	18.3	1.02	04:40:00	275.0	0.94	68.5	13.3	0.67
01:05:00	60.0	0.21	90.5	17.6	0.97	04:50:00	285.0	0.98	69.0	13.4	0.67
01:12:30	67.5	0.23	91.5	17.9	0.99	05:00:00	295.0	1.01	71.0	13.9	0.71
01:25:00	80.0	0.27	92.0	18.0	1.00	05:26:00	321.0	1.10	73.0	14.3	0.74
01:34:00	89.0	0.30	94.5	18.5	1.04	05:30:00	325.0	1.11	73.0	14.3	0.74
02:02:20	117.3	0.40	93.5	18.3	1.02	05:40:00	335.0	1.15	73.5	14.4	0.75
02:55:00	170.0	0.58	92.5	18.1	1.01	05:50:00	345.0	1.18	74.5	14.6	0.76
03:55:00	230.0	0.79	91.0	17.8	0.98	06:00:00	355.0	1.22	74.5	14.6	0.76
04:55:00	290.0	0.99	92.0	18.0	1.00	06:13:00	368.0	1.26	75.5	14.9	0.78
05:55:00	350.0	1.20	93.0	18.2	1.01	06:20:00	375.0	1.28	76.0	15.0	0.79
06:55:00	410.0	1.40	92.0	18.0	1.00	06:30:30	385.5	1.32	76.5	15.1	0.79
07:53:00	468.0	1.60	90.5	17.6	0.97	06:40:00	395.0	1.35	76.5	15.1	0.79
08:35:00	530.0	1.82	96.0	18.8	1.06	06:50:00	405.0	1.39	76.5	15.1	0.79
09:55:00	590.0	2.02	85.5	16.6	0.90	07:00:00	415.0	1.42	77.0	15.2	0.80
10:53:00	648.0	2.22	102.0	20.1	1.15	07:10:00	425.0	1.46	78.0	15.4	0.82
11:54:00	709.0	2.43	91.5	17.9	0.99	07:20:00	435.0	1.49	78.0	15.4	0.82
12:53:00	768.0	2.63	88.0	17.1	0.94	07:30:00	445.0	1.52	79.0	15.7	0.83
						07:40:00	455.0	1.56	78.0	15.4	0.82
						07:50:00	465.0	1.59	79.0	15.7	0.83
						08:00:00	475.0	1.63	78.5	15.5	0.83
						08:13:00	488.0	1.67	80.5	16.0	0.86
						08:20:00	495.0	1.70	81.5	16.2	0.87
						08:30:00	505.0	1.73	81.0	16.1	0.87
						08:40:00	515.0	1.76	79.0	15.7	0.83
						08:50:00	525.0	1.80	79.5	15.8	0.84
						09:00:00	535.0	1.83	81.0	16.1	0.87
						09:10:00	545.0	1.87	84.0	16.8	0.91
						09:20:00	555.0	1.90	84.5	16.9	0.92
						09:30:00	565.0	1.93	84.0	16.8	0.91
						09:40:00	575.0	1.97	85.5	17.1	0.94
						09:50:00	585.0	2.00	86.0	17.2	0.94
						10:00:00	595.0	2.04	85.0	17.0	0.93
						10:12:00	607.0	2.08	86.0	17.2	0.94
						10:20:00	615.0	2.11	87.0	17.4	0.96
						10:30:00	625.0	2.14	87.5	17.6	0.97
						10:40:00	635.0	2.17	86.0	17.2	0.94
						10:50:00	645.0	2.21	85.0	17.0	0.93
						10:58:00	653.0	2.24	88.0	17.7	0.98
						11:10:00	665.0	2.28	89.5	18.0	1.00
						11:20:00	675.0	2.31	88.5	17.8	0.98
						11:32:00	687.0	2.35	88.0	17.7	0.98
						11:40:00	695.0	2.38	89.0	17.9	0.99
						11:50:00	705.0	2.41	90.0	18.1	1.01
						12:03:00	718.0	2.46	88.5	17.8	0.98
						12:10:00	725.0	2.48	90.0	18.1	1.01

12:20:00	735.0	2.52	89.0	17.9	0.99
12:30:00	745.0	2.55	87.5	17.6	0.97
12:40:00	755.0	2.59	87.5	17.6	0.97
12:50:00	765.0	2.62	88.0	17.7	0.98
13:00:00	775.0	2.65	89.5	18.0	1.00
13:13:00	788.0	2.70	89.0	17.9	0.99
13:20:00	795.0	2.72	89.5	18.0	1.00
13:30:00	805.0	2.76	89.5	18.0	1.00
13:40:00	815.0	2.79	89.5	18.0	1.00
13:50:00	825.0	2.83	89.5	18.0	1.00
14:00:00	835.0	2.86	89.5	18.0	1.00
14:10:00	845.0	2.89	89.5	18.0	1.00
14:16:00	851.0	2.91	89.5	18.0	1.00

Gnrl Eqn: y=0.215x-1.813

	(INLET)	(OUTLET)	
Na start:	3.92	3.88	
Na finish:	18.00	17.43	
Initial:	26.7	26.5	(avearge of 3 first samples)
Steady:	92.1	89.5	(average of 3 last samples)
			(assumed Steady Inlet =before noises started at 08:55))

m= 0.2
b= -1.8

System					Background					
Time In	TOut-Tin	T/Td	Time Correction		Time		t/Td	Reading	Conc. Na	C/Co
Eqvl.	min	Td=292	C/Co	Time(min)	min	min	Td=292		mg/L	
18.0	0.0	0.00	0.00	25.0	00:05:00	0.0	0.00	25.5	3.7	0.0
25.0	0.0	0.00	0.05	26.0	01:44:00	99.0	0.34	25.0	3.6	0.0
25.0	0.0	0.00	0.10	27.0	02:05:00	120.0	0.41	24.5	3.5	0.0
25.0	1.3	0.00	0.15	28.0	03:05:00	180.0	0.62	25.0	3.6	0.0
25.0	11.5	0.04	0.20	28.5	04:08:00	243.0	0.83	25.0	3.6	0.0
28.2	18.8	0.06	0.25	29.0	05:17:00	312.0	1.07	25.0	3.6	0.0
29.2	27.6	0.09	0.30	29.5	06:04:00	359.0	1.23	25.5	3.7	0.0
29.2	35.8	0.12	0.35	30.0	07:15:00	430.0	1.47	25.5	3.7	0.0
29.4	47.6	0.16	0.40	31.0	08:06:00	481.0	1.65	26.0	3.8	0.0
29.5	55.5	0.19	0.45	31.5	09:00:00	535.0	1.83	26.5	3.9	0.0
29.8	65.2	0.22	0.50	32.0	10:05:00	600.0	2.05	26.5	3.9	0.0
31.4	73.6	0.25	0.55	32.5	11:02:30	657.5	2.25	27.0	4.0	0.0
31.3	83.7	0.29	0.60	33.0	12:00:00	715.0	2.45	27.0	4.0	0.0
31.4	93.6	0.32	0.65	34.0	13:03:00	778.0	2.66	27.0	4.0	0.0
31.5	103.5	0.35	0.70	34.5						
31.7	113.3	0.39	0.75	35.0						
32.1	122.9	0.42	0.80	37.0						
32.2	132.8	0.45	0.85	36.0						
32.5	142.5	0.49	0.90	40.0						
32.6	155.9	0.53	0.95	43.0						
32.8	162.2	0.56	1.00	48.0						
33.0	173.5	0.59								
33.1	181.9	0.62								
33.2	191.8	0.66								
33.5	201.5	0.69								
33.5	211.5	0.72								
34.0	221.0	0.76								
34.0	231.0	0.79								
34.2	240.8	0.82								
34.2	250.8	0.86								
34.6	260.4	0.89								
34.9	286.1	0.98								
34.9	290.1	0.99								
35.0	300.0	1.03								
35.5	309.5	1.06								
35.5	319.5	1.09								
36.1	331.9	1.14								
36.4	338.6	1.16								
36.7	348.8	1.19								
36.7	358.3	1.23								
36.7	368.3	1.26								
37.0	378.0	1.29								
37.3	387.7	1.33								
37.3	397.7	1.36								
37.7	407.3	1.39								
37.3	417.7	1.43								
37.7	427.3	1.46								
37.5	437.5	1.50								
38.3	449.7	1.54								
38.9	456.1	1.56								
38.6	466.4	1.60								
37.7	477.3	1.63								
37.8	487.2	1.67								
38.6	496.4	1.70								
40.8	504.2	1.73								
41.2	513.8	1.76								
40.8	524.2	1.80								
42.2	532.8	1.82								
42.7	542.3	1.86								
41.7	553.3	1.89								
42.7	564.3	1.93								
44.0	571.0	1.96								
44.8	580.2	1.99								
42.7	592.3	2.03								
41.7	603.3	2.07								
45.6	607.4	2.08								
48.0	617.0	2.11								
46.4	628.6	2.15								
45.6	641.4	2.20								
47.2	647.8	2.22								
48.0	657.0	2.25								
46.4	671.6	2.30								
48.0	677.0	2.32								

47.2	687.8	2.36
44.8	700.2	2.40
44.8	710.2	2.43
45.6	719.4	2.46
48.0	727.0	2.49
47.2	740.8	2.54
48.0	747.0	2.56
48.0	757.0	2.59
48.0	767.0	2.63
48.0	777.0	2.66
48.0	787.0	2.70
48.0	797.0	2.73
48.0	803.0	2.75

SAMPLING NO:	**7**
LOCATION:	**Reservoir 3**
FLOW (ML/d):	179
SAMPLING DATE:	28-Apr-93
TESTING DATE:	02-May-93
STANDARD MADE:	09-Apr-93

STANDARDIZATION

mg/L Na	Initial Reading	Final Reading	Average
2.5	18.5	18.5	18.5
5.0	33.5	34.0	33.8
10.0	59.0	59.5	59.3
15.0	81.0	81.5	81.3
17.5	91.0	91.5	91.3
20.0	100.0	101.0	100.5

Regression Statistics

Multiple R	0.998
R Square	0.995
Adjusted R Square	0.994
Standard Error	0.543
Observations	6

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	244.652	244.652	828.319	0.000
Residual	4	1.181	0.295		
Total	5	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.999	0.524	-3.814	0.012	-3.454	-0.544
x1	0.213	0.007	28.781	0.000	0.193	0.234

General Equation: y=0.213x-1.999

TEST NO. 7
RESERVOIR NO. 3 (179 ML/d)

NaBack(mg/L)=	4.39	m=	0.2	m=	0.2
NaFinal(mg/L)=	16.46	b=	-2.0	b=	-2.1
NaTracer(mg/L)=	12.07				

Inlet						Outlet					
Time		t/Td	Reading	Conc. Na	C/Co	Time		t/Td	Reading	Conc. Na	C/Co
min	min	Td=283		mg/L	Data	min	min	Td=283		mg/L	Initial
00:05:00	0.0	0.00	30.0	4.4	0.00	00:10:00	5.0	0.02	29.5	4.4	0.00
00:06:00	1.0	0.00	30.0	4.4	0.00	00:20:00	15.0	0.05	29.5	4.4	0.00
00:07:00	2.0	0.01	30.0	4.4	0.00	00:30:00	25.0	0.09	29.5	4.4	0.00
00:08:00	3.0	0.01	30.0	4.4	0.00	00:40:00	35.0	0.12	35.0	5.6	0.10
00:09:00	4.0	0.01	29.5	4.3	-0.01	00:50:00	45.0	0.16	43.0	7.4	0.25
00:10:00	5.0	0.02	31.0	4.6	0.02	01:00:00	55.0	0.19	44.0	7.6	0.26
00:11:00	6.0	0.02	29.5	4.3	-0.01	01:10:30	65.5	0.23	43.5	7.5	0.26
00:12:00	7.0	0.02	29.5	4.3	-0.01	01:20:00	75.0	0.27	47.0	8.2	0.32
00:13:00	8.0	0.03	29.0	4.2	-0.02	01:30:00	85.0	0.30	49.0	8.7	0.36
00:14:00	9.0	0.03	29.0	4.2	-0.02	01:40:00	95.0	0.34	53.0	9.6	0.43
00:15:00	10.0	0.04	30.0	4.4	0.00	01:50:00	105.0	0.37	53.0	9.6	0.43
00:16:00	11.0	0.04	29.0	4.2	-0.02	02:00:00	115.0	0.41	55.0	10.0	0.47
00:17:00	12.0	0.04	29.0	4.2	-0.02	02:11:30	126.5	0.45	57.0	10.4	0.50
00:18:00	13.0	0.05	28.5	4.1	-0.03	02:20:00	135.0	0.48	58.5	10.8	0.53
00:19:00	14.0	0.05	29.0	4.2	-0.02	02:30:00	145.0	0.51	58.5	10.8	0.53
00:20:00	15.0	0.05	29.0	4.2	-0.02	02:40:00	155.0	0.55	58.0	10.7	0.52
00:21:00	16.0	0.06	29.0	4.2	-0.02	02:50:00	165.0	0.58	60.0	11.1	0.56
00:22:00	17.0	0.06	29.5	4.3	-0.01	03:00:00	175.0	0.62	61.0	11.3	0.57
00:23:00	18.0	0.06	29.0	4.2	-0.02	03:10:00	185.0	0.65	62.0	11.5	0.59
00:24:00	19.0	0.07	29.0	4.2	-0.02	03:20:00	195.0	0.69	63.0	11.8	0.61
00:25:00	20.0	0.07	29.0	4.2	-0.02	03:30:00	205.0	0.72	64.5	12.1	0.64
00:26:00	21.0	0.07	29.5	4.3	-0.01	03:40:00	215.0	0.76	66.5	12.5	0.67
00:27:00	22.0	0.08	33.0	5.0	0.05	03:50:00	225.0	0.80	67.5	12.8	0.69
00:28:00	23.0	0.08	38.5	6.2	0.15	04:00:00	235.0	0.83	67.0	12.6	0.68
00:29:00	24.0	0.08	44.5	7.5	0.26	04:10:00	245.0	0.87	68.0	12.9	0.70
00:30:00	25.0	0.09	51.0	8.9	0.37	04:21:00	256.0	0.90	69.0	13.1	0.72
00:31:00	26.0	0.09	60.0	10.8	0.53	04:35:00	270.0	0.95	69.5	13.2	0.73
00:32:00	27.0	0.10	65.0	11.8	0.62	04:40:00	275.0	0.97	70.0	13.3	0.74
00:33:00	28.0	0.10	71.0	13.1	0.72	04:50:00	285.0	1.01	72.0	13.7	0.78
00:34:00	29.0	0.10	75.0	14.0	0.79	05:00:00	295.0	1.04	71.0	13.5	0.76
00:35:00	30.0	0.11	78.5	14.7	0.86	05:10:00	305.0	1.08	71.0	13.5	0.76
00:40:00	35.0	0.12	84.0	15.9	0.95	05:20:00	315.0	1.11	71.0	13.5	0.76
00:46:20	41.3	0.15	84.5	16.0	0.96	05:30:00	325.0	1.15	71.5	13.6	0.77
00:50:00	45.0	0.16	85.5	16.2	0.98	05:40:00	335.0	1.18	72.5	13.9	0.78
00:55:00	50.0	0.18	87.0	16.5	1.01	05:50:00	345.0	1.22	74.5	14.3	0.82
01:03:00	58.0	0.20	87.0	16.5	1.01	06:00:00	355.0	1.25	73.0	14.0	0.79
01:15:00	70.0	0.25	87.0	16.5	1.01	06:11:30	366.5	1.30	72.5	13.9	0.78
01:25:00	80.0	0.28	88.5	16.9	1.03	06:20:00	375.0	1.33	73.0	14.0	0.79
01:35:00	90.0	0.32	88.5	16.9	1.03	06:30:00	385.0	1.36	76.5	14.7	0.86
01:55:00	110.0	0.39	88.5	16.9	1.03	06:40:00	395.0	1.40	77.0	14.8	0.87
02:55:00	170.0	0.60	88.5	16.9	1.03	06:50:00	405.0	1.43	78.0	15.1	0.88
03:55:00	230.0	0.81	89.0	17.0	1.04	07:00:00	415.0	1.47	78.0	15.1	0.88
04:55:00	290.0	1.02	89.0	17.0	1.04	07:11:00	426.0	1.51	79.0	15.3	0.90
05:55:00	350.0	1.24	87.0	16.5	1.01	07:22:00	437.0	1.54	78.0	15.1	0.88
06:55:00	410.0	1.45	85.0	16.1	0.97	07:30:00	445.0	1.57	78.5	15.2	0.89
07:53:00	468.0	1.65	89.0	17.0	1.04	07:40:00	455.0	1.61	77.5	15.0	0.88
08:55:00	530.0	1.87	88.0	16.7	1.02	07:50:00	465.0	1.64	78.0	15.1	0.88
09:55:00	590.0	2.08	92.5	17.7	1.10	08:00:00	475.0	1.68	80.0	15.5	0.92
10:55:00	650.0	2.30	87.5	16.6	1.01	08:10:00	485.0	1.71	79.0	15.3	0.90
11:55:00	710.0	2.51	86.0	16.3	0.99	08:20:00	495.0	1.75	79.0	15.3	0.90
12:55:00	770.0	2.72	88.5	16.9	1.03	08:30:00	505.0	1.78	79.5	15.4	0.91
14:00:00	835.0	2.95	85.5	16.2	0.98	08:40:00	515.0	1.82	79.5	15.4	0.91
						08:50:00	525.0	1.86	82.0	15.9	0.96
						09:00:00	535.0	1.89	82.5	16.1	0.97
						09:10:00	545.0	1.93	82.5	16.1	0.97
						09:20:00	555.0	1.96	82.5	16.1	0.97
						09:30:00	565.0	2.00	83.0	16.2	0.98
						09:40:00	575.0	2.03	83.0	16.2	0.98
						09:50:00	585.0	2.07	83.5	16.3	0.98
						10:00:00	595.0	2.10	85.0	16.6	1.01
						10:10:00	605.0	2.14	84.0	16.4	0.99
						10:20:00	615.0	2.17	84.0	16.4	0.99
						10:30:00	625.0	2.21	84.5	16.5	1.00
						10:40:00	635.0	2.24	85.0	16.6	1.01
						10:50:00	645.0	2.28	85.0	16.6	1.01
						11:00:00	655.0	2.31	83.5	16.3	0.98
						11:10:00	665.0	2.35	83.0	16.2	0.98
						11:20:00	675.0	2.39	83.0	16.2	0.98
						11:30:00	685.0	2.42	84.0	16.4	0.99
						11:40:00	695.0	2.46	84.0	16.4	0.99
						11:50:00	705.0	2.49	83.5	16.3	0.98
						12:00:00	715.0	2.53	84.5	16.5	1.00
						12:10:00	725.0	2.56	84.5	16.5	1.00

12:20:00	735.0	2.60	85.5	16.7	1.02
12:30:00	745.0	2.63	85.5	16.7	1.02
12:40:00	755.0	2.67	85.5	16.7	1.02
12:50:00	765.0	2.70	86.0	16.8	1.03
13:00:00	775.0	2.74	86.0	16.8	1.03
13:10:00	785.0	2.77	86.5	16.9	1.04
13:20:00	795.0	2.81	86.0	16.8	1.03
13:30:00	805.0	2.84	85.5	16.7	1.02
13:40:00	815.0	2.88	83.0	16.2	0.98
13:50:00	825.0	2.92	85.0	16.6	1.01
14:00:00	835.0	2.95	85.0	16.6	1.01

Gnrl Eqn: 0.213x-1.999

	(INLET)	(OUTLET)	
Na start:	4.39	4.39	
Na finish:	16.46	16.46	
First condition:	30.0	29.5	(aveerge of 3 first samples)
Steady condition:	86.7	84.3	(average of 3 last samples)

m= 0.2
b= -2.0

System			Time Correction		Background					
Time In	TOut-Tin	T/Td	C/Co	Time(min)	Time		t/Td	Reading	Conc. Na	C/Co
Eqvl.	min	Td=283			min	min	Td=283		mg/L	
21.0	0.0	0.00	0.00	21.0	00:05:00	0.0	0.00	28.5	4.1	0.0
21.0	0.0	0.00	0.05	22.0	01:00:00	55.0	0.19	28.5	4.1	0.0
21.0	4.0	0.01	0.10	22.5	02:00:00	115.0	0.41	28.5	4.1	0.0
22.5	12.5	0.04	0.15	23.0	03:00:00	175.0	0.62	28.5	4.1	0.0
24.0	21.0	0.07	0.20	23.5	04:00:00	235.0	0.83	29.0	4.2	0.0
24.1	30.9	0.11	0.25	24.0	05:00:00	295.0	1.04	29.0	4.2	0.0
24.1	41.4	0.15	0.30	24.5	06:00:00	355.0	1.25	29.0	4.2	0.0
24.7	50.3	0.18	0.35	25.0	07:00:00	415.0	1.47	29.0	4.2	0.0
25.0	60.0	0.21	0.40	25.0	08:00:00	475.0	1.68	29.5	4.3	0.0
25.3	69.7	0.25	0.45	25.5	09:00:00	535.0	1.89	29.5	4.3	0.0
25.3	79.7	0.28	0.50	26.0	10:00:00	595.0	2.10	29.5	4.3	0.0
25.7	89.3	0.32	0.55	26.5	11:00:00	655.0	2.31	29.5	4.3	0.0
26.0	100.5	0.36	0.60	27.0	12:00:00	715.0	2.53	30.0	4.4	0.0
26.3	108.7	0.38	0.65	27.5	13:07:00	782.0	2.76	30.5	4.5	0.0
26.3	118.7	0.42	0.70	28.0						
26.2	128.8	0.46	0.75	28.5						
26.6	138.4	0.49	0.80	29.0						
26.7	148.3	0.52	0.85	30.0						
26.9	158.1	0.56	0.90	32.0						
27.1	167.9	0.59	0.95	35.0						
27.4	177.6	0.63	1.00	48.0						
27.7	187.3	0.66								
27.9	197.1	0.70								
27.8	207.2	0.73								
28.0	217.0	0.77								
28.2	227.8	0.80								
28.3	241.7	0.85								
28.4	246.6	0.87								
28.8	256.2	0.91								
28.6	266.4	0.94								
28.6	276.4	0.98								
28.6	286.4	1.01								
28.7	296.3	1.05								
28.8	306.2	1.08								
29.4	315.6	1.12								
28.9	326.1	1.15								
28.8	337.7	1.19								
28.9	346.1	1.22								
30.3	354.7	1.25								
30.7	364.3	1.29								
31.4	373.6	1.32								
31.4	383.6	1.36								
32.2	393.8	1.39								
31.4	405.6	1.43								
31.7	413.3	1.46								
31.0	424.0	1.50								
31.4	433.6	1.53								
33.3	441.7	1.56								
32.2	452.8	1.60								
32.2	462.8	1.64								
32.7	472.3	1.67								
32.7	482.3	1.70								
36.9	488.1	1.72								
39.3	495.7	1.75								
39.3	505.7	1.79								
39.3	515.7	1.82								
41.7	523.3	1.85								
41.7	533.3	1.88								
44.0	541.0	1.91								
48.0	547.0	1.93								
46.4	558.6	1.97								
46.4	568.6	2.01								
48.0	577.0	2.04								
48.0	587.0	2.07								
48.0	597.0	2.11								
44.0	611.0	2.16								
41.7	623.3	2.20								
41.7	633.3	2.24								
46.4	638.6	2.26								
46.4	648.6	2.29								
44.0	661.0	2.34								
48.0	667.0	2.36								
48.0	677.0	2.39								

48.0	687.0	2.43
48.0	697.0	2.46
48.0	707.0	2.50
48.0	717.0	2.53
48.0	727.0	2.57
48.0	737.0	2.60
48.0	747.0	2.64
48.0	757.0	2.67
41.7	773.3	2.73
48.0	777.0	2.75
48.0	787.0	2.78

SAMPLING NO:	**8**
LOCATION:	**Reservoir 1**
FLOW (ML/d):	230
SAMPLING DATE:	18-Jun-93
TESTING DATE:	19-Jun-93
STANDARD MADE:	19-Jun-93

STANDARDIZATION

mg/L Na	Initial Reading	Initial Reading	Average
2.5	18.5	18.0	18.3
5.0	33.0	32.5	32.8
10.0	61.0	58.5	59.8
15.0	82.5	80.5	81.5
17.5	91.5	90.0	90.8
20.0	100.0	99.0	99.5

Regression Statistics

Multiple R	0.997
R Square	0.993
Adjusted R Square	0.992
Standard Error	0.645
Observations	6

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	244.167	244.167	586.172	0.000
Residual	4	1.666	0.417		
Total	5	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.928	0.620	-3.108	0.027	-3.650	-0.206
x1	0.213	0.009	24.211	0.000	0.189	0.238

General Equation: y=0.213x-1.928

TEST NO. 8
RESERVOIR NO. 1 (230 ML/d)

NaBack(mg/L)=	3.08	m=	0.2	m=	0.2
NaFinal(mg/L)=	16.65	b=	-1.9	b=	-1.7
NaTracer(mg/L)=	13.57				

Inlet						Outlet					
Time		t/Td	Reading	Conc. Na	C/Co	Time		t/Td	Reading	Conc. Na	C/Co
min	min	Td=220		mg/L	Initial	min	min	Td=220		mg/L	Initial
00:05:00	0.0	0.00	23.5	3.1	0.00	00:05:00	0.0	0.0	22.5	3.0	0.00
00:06:00	1.0	0.00	23.5	3.1	0.00	00:10:00	5.0	0.0	22.5	3.0	0.00
00:07:00	2.0	0.01	23.5	3.1	0.00	00:20:00	15.0	0.1	23.0	3.1	0.01
00:08:00	3.0	0.01	23.5	3.1	0.00	00:30:00	25.0	0.1	22.5	3.0	0.00
00:09:00	4.0	0.02	23.5	3.1	0.00	00:40:00	35.0	0.2	22.5	3.0	0.00
00:10:00	5.0	0.02	23.5	3.1	0.00	00:50:00	45.0	0.2	22.5	3.0	0.00
00:11:00	6.0	0.03	23.5	3.1	0.00	01:00:00	55.0	0.3	34.0	5.5	0.18
00:12:00	7.0	0.03	23.5	3.1	0.00	01:10:00	65.0	0.3	48.5	8.5	0.40
00:13:00	8.0	0.04	23.5	3.1	0.00	01:25:00	80.0	0.4	46.5	8.1	0.37
00:14:00	9.0	0.04	24.0	3.2	0.01	01:40:00	95.0	0.4	49.0	8.6	0.41
00:15:00	10.0	0.05	28.5	4.1	0.08	01:50:00	105.0	0.5	52.5	9.3	0.46
00:16:00	11.0	0.05	38.0	6.2	0.23	02:00:00	115.0	0.5	55.5	10.0	0.51
00:17:00	12.0	0.05	47.5	8.2	0.38	02:10:00	125.0	0.6	57.0	10.3	0.53
00:18:00	13.0	0.06	70.5	13.1	0.74	02:20:00	135.0	0.6	62.0	11.3	0.61
00:19:00	14.0	0.06	70.5	13.1	0.74	02:30:00	145.0	0.7	63.5	11.7	0.63
00:20:00	15.0	0.07	77.5	14.6	0.85	02:40:00	155.0	0.7	64.0	11.8	0.64
00:21:00	16.0	0.07	76.5	14.4	0.83	02:50:00	165.0	0.8	65.0	12.0	0.66
00:22:00	17.0	0.08	78.5	14.8	0.86	03:00:00	175.0	0.8	66.5	12.3	0.68
00:23:00	18.0	0.08	86.0	16.4	0.98	03:10:00	185.0	0.8	69.0	12.8	0.72
00:24:00	19.0	0.09	85.5	16.3	0.97	03:20:00	195.0	0.9	71.0	13.2	0.75
00:25:00	20.0	0.09	82.0	15.5	0.92	03:30:00	205.0	0.9	72.0	13.4	0.76
00:26:00	21.0	0.10	86.0	16.4	0.98	03:40:00	215.0	1.0	73.0	13.7	0.78
00:27:00	22.0	0.10	87.0	16.6	1.00	03:50:00	225.0	1.0	77.0	14.5	0.84
00:28:00	23.0	0.10	82.0	15.5	0.92	04:10:00	245.0	1.1	77.5	14.6	0.85
00:29:00	24.0	0.11	86.0	16.4	0.98	04:20:00	255.0	1.2	77.5	14.6	0.85
00:30:00	25.0	0.11	82.5	15.6	0.93	04:30:00	265.0	1.2	78.0	14.7	0.86
00:31:00	26.0	0.12	86.5	16.5	0.99	04:40:00	275.0	1.3	80.0	15.1	0.89
00:32:00	27.0	0.12	84.0	16.0	0.95	04:50:00	285.0	1.3	81.0	15.3	0.90
00:33:00	28.0	0.13	85.0	16.2	0.97	05:00:00	295.0	1.3	80.5	15.2	0.90
00:34:00	29.0	0.13	84.0	16.0	0.95	05:10:00	305.0	1.4	82.5	15.7	0.93
00:35:00	30.0	0.14	84.5	16.1	0.96	05:20:00	315.0	1.4	84.0	16.0	0.95
00:40:00	35.0	0.16	84.5	16.1	0.96	05:30:00	325.0	1.5	84.0	16.0	0.95
00:45:00	40.0	0.18	87.0	16.6	1.00	05:40:00	335.0	1.5	83.0	15.8	0.93
00:50:00	45.0	0.20	87.5	16.7	1.00	05:50:00	345.0	1.6	84.0	16.0	0.95
00:55:00	50.0	0.23	88.5	16.9	1.02	06:00:00	355.0	1.6	81.0	15.3	0.90
01:00:00	55.0	0.25	87.0	16.6	1.00	06:10:00	365.0	1.7	83.0	15.8	0.93
01:05:00	60.0	0.27	82.5	15.6	0.93	06:20:00	375.0	1.7	84.0	16.0	0.95
02:00:00	115.0	0.52	87.5	16.7	1.00	06:30:00	385.0	1.8	84.0	16.0	0.95
03:00:00	175.0	0.80	88.5	16.9	1.02	06:40:00	395.0	1.8	84.5	16.1	0.96
04:00:00	235.0	1.07	87.0	16.6	1.00	06:50:00	405.0	1.8	85.5	16.3	0.97
05:40:00	335.0	1.52	89.0	17.0	1.03	07:00:00	415.0	1.9	85.0	16.2	0.97
06:00:00	355.0	1.61	91.0	17.5	1.06	07:10:00	425.0	1.9	86.0	16.4	0.98
07:00:00	415.0	1.89	91.0	17.5	1.06	07:20:00	435.0	2.0	86.5	16.5	0.99
08:00:00	475.0	2.16	87.0	16.6	1.00	07:30:00	445.0	2.0	87.0	16.6	1.00
08:55:00	530.0	2.41	91.0	17.5	1.06	07:40:00	455.0	2.1	87.5	16.7	1.00
						07:50:00	465.0	2.1	88.0	16.8	1.01
						08:00:00	475.0	2.2	87.5	16.7	1.00
						08:10:00	485.0	2.2	87.0	16.6	1.00
						08:20:00	495.0	2.3	87.5	16.7	1.00
						08:30:00	505.0	2.3	87.0	16.6	1.00
						08:44:00	519.0	2.4	87.0	16.6	1.00
						08:50:00	525.0	2.4	87.0	16.6	1.00
						09:00:00	535.0	2.4	86.5	16.5	0.99

Gnrl Eqn: 0.213x - 1.928

	(INLET)	(OUTLET)	
Na start	3.08	2.90	
Na finish	16.65	16.65	
First condition:	23.5	22.7	(average of 3 first samples)
Steady condition:	87.2	87.2	(average of 10 last samples)
			(assumed steady state for Inlet = Outlet)

m= 0.2
b= -1.9

System					Background					
Time In	TOut-TIn	T/Td	Time Correction		Time		t/Td	Reading	Conc. Na	C/Co
Eqvl.	min	Td=220	C/Co	Time(min)	min	min	Td=220		mg/L	
9.0	0.0	0.00	0.00	9.0	00:05:00	0.0	0.0	23.5	3.1	0.0
9.0	0.0	0.00	0.05	9.5	01:00:00	55.0	0.3	24.0	3.2	0.0
9.1	5.9	0.03	0.10	10.0	02:00:00	115.0	0.5	24.0	3.2	0.0
9.0	16.0	0.07	0.15	10.5	03:00:00	175.0	0.8	24.5	3.3	0.0
9.0	26.0	0.12	0.20	11.0	04:00:00	235.0	1.1	24.0	3.2	0.0
9.0	36.0	0.16	0.25	11.5	05:00:00	295.0	1.3	23.5	3.1	0.0
10.8	44.2	0.20	0.30	11.5	06:00:00	355.0	1.6	24.5	3.3	0.0
12.0	53.0	0.24	0.35	12.0	07:00:00	415.0	1.9	24.5	3.3	0.0
12.0	68.0	0.31	0.40	12.0	08:00:00	475.0	2.2	24.0	3.2	0.0
12.0	83.0	0.38	0.45	12.0	09:00:00	535.0	2.4	24.5	3.3	0.0
12.1	92.9	0.42	0.50	12.5						
12.5	102.5	0.47	0.55	12.5						
12.5	112.5	0.51	0.60	13.0						
13.0	122.0	0.55	0.65	13.0						
13.0	132.0	0.60	0.70	13.0						
13.0	142.0	0.65	0.75	14.0						
13.0	152.0	0.69	0.80	14.5						
13.0	162.0	0.74	0.85	15.0						
13.4	171.6	0.78	0.90	17.5						
14.0	181.0	0.82	0.95	18.0						
14.1	190.9	0.87	1.00	22.0						
14.3	200.7	0.91								
14.9	210.1	0.95								
15.0	230.0	1.05								
15.0	240.0	1.09								
15.4	249.6	1.13								
16.9	258.1	1.17								
17.5	267.5	1.22								
17.3	277.7	1.26								
17.8	287.2	1.31								
18.0	297.0	1.35								
18.0	307.0	1.40								
17.8	317.2	1.44								
18.0	327.0	1.49								
17.5	337.5	1.53								
17.8	347.2	1.58								
18.0	357.0	1.62								
18.0	367.0	1.67								
18.7	376.3	1.71								
19.9	385.1	1.75								
19.3	395.7	1.80								
20.5	404.5	1.84								
21.1	413.9	1.88								
21.8	423.2	1.92								
22.0	433.0	1.97								
22.0	443.0	2.01								
22.0	453.0	2.06								
21.8	463.2	2.11								
22.0	473.0	2.15								
21.8	483.2	2.20								
21.8	497.2	2.26								
21.8	503.2	2.29								
21.1	513.9	2.34								

SAMPLING NO:	**9**
LOCATION:	**Reservoir 3**
FLOW (ML/d):	198
SAMPLING DATE:	25-Jun-93
TESTING DATE:	26-Jun-93
STANDARD MADE:	19-Jun-93

STANDARDIZATION

mg/L Na	Initial Reading	Initial Reading	Average
2.5	19.0	19.0	19.0
5.0	33.0	33.0	33.0
10.0	59.5	59.5	59.5
15.0	80.0	80.5	80.3
17.5	89.5	89.5	89.5
20.0	100.0	100.0	100.0

Regression Statistics

Multiple R	0.998
R Square	0.995
Adjusted R Square	0.994
Standard Error	0.542
Observations	6

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	244.657	244.657	831.705	0.000
Residual	4	1.177	0.294		
Total	5	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.096	0.526	-3.984	0.010	-3.556	-0.635
x1	0.217	0.008	28.839	0.000	0.196	0.237

General Equation: y=0.217x-2.096

TEST NO.
RESERVOIR NO. 3 (198 ML/d)

NaBack(mg/L)=	3.44	m=	0.2	m=	0.2
NaFinal(mg/L)=	17.08	b=	-2.1	b=	-2.6
NaTracer(mg/L)=	13.64				

Inlet						Outlet					
Time		t/Td	Reading	Conc. Na	C/Co	Time		t/Td	Reading	Conc. Na	C/Co
min	min	Td=318		mg/L		min	min	Td=318		mg/L	
00:05:00	0.0	0.00	25.5	3.4	0.00	00:05:00	0.0	0.00	27.0	3.4	0.00
00:06:00	1.0	0.00	25.5	3.4	0.00	00:10:00	5.0	0.02	27.0	3.4	0.00
00:07:00	2.0	0.01	25.5	3.4	0.00	00:15:00	10.0	0.03	27.0	3.4	0.00
00:08:00	3.0	0.01	26.0	3.5	0.01	00:20:00	15.0	0.05	27.0	3.4	0.00
00:09:00	4.0	0.01	26.0	3.5	0.01	00:25:00	20.0	0.06	27.0	3.4	0.00
00:10:00	5.0	0.02	28.5	4.1	0.05	00:30:00	25.0	0.08	27.5	3.5	0.01
00:11:00	6.0	0.02	27.0	3.8	0.02	00:35:00	30.0	0.09	29.0	3.9	0.03
00:12:00	7.0	0.02	28.0	4.0	0.04	00:40:00	35.0	0.11	36.0	5.4	0.15
00:13:00	8.0	0.03	27.0	3.8	0.02	00:45:00	40.0	0.13	41.5	6.7	0.24
00:14:00	9.0	0.03	27.0	3.8	0.02	00:50:00	45.0	0.14	42.0	6.8	0.24
00:15:00	10.0	0.03	27.0	3.8	0.02	00:55:00	50.0	0.16	43.0	7.0	0.26
00:16:00	11.0	0.03	26.5	3.7	0.02	01:00:00	55.0	0.17	43.5	7.1	0.27
00:17:00	12.0	0.04	27.0	3.8	0.02	01:10:00	65.0	0.20	43.5	7.1	0.27
00:18:00	13.0	0.04	26.5	3.7	0.02	01:20:00	75.0	0.24	45.0	7.4	0.29
00:19:00	14.0	0.04	27.0	3.8	0.02	01:30:00	85.0	0.27	47.0	7.9	0.33
00:20:00	15.0	0.05	28.0	4.0	0.04	01:42:00	97.0	0.31	51.5	8.9	0.40
00:21:00	16.0	0.05	27.0	3.8	0.02	01:52:00	107.0	0.34	51.0	8.8	0.39
00:22:00	17.0	0.05	27.5	3.9	0.03	01:55:00	110.0	0.35	52.0	9.0	0.41
00:23:00	18.0	0.06	27.5	3.9	0.03	02:15:00	130.0	0.41	52.5	9.1	0.42
00:24:00	19.0	0.06	26.5	3.7	0.02	02:20:00	135.0	0.42	55.5	9.8	0.46
00:25:00	20.0	0.06	26.5	3.7	0.02	02:30:00	145.0	0.46	59.0	10.6	0.52
00:26:00	21.0	0.07	26.5	3.7	0.02	02:40:00	155.0	0.49	59.5	10.7	0.53
00:27:00	22.0	0.07	27.0	3.8	0.02	02:50:00	165.0	0.52	60.0	10.8	0.54
00:28:00	23.0	0.07	31.5	4.7	0.10	02:55:00	170.0	0.53	60.5	10.9	0.55
00:29:00	24.0	0.08	41.0	6.8	0.25	03:10:00	185.0	0.58	62.5	11.3	0.58
00:30:00	25.0	0.08	48.0	8.3	0.36	03:20:00	195.0	0.61	63.0	11.4	0.59
00:31:00	26.0	0.08	57.5	10.4	0.51	03:30:00	205.0	0.64	65.0	11.9	0.62
00:32:00	27.0	0.08	67.0	12.4	0.66	03:40:00	215.0	0.68	64.5	11.8	0.61
00:33:00	28.0	0.09	72.0	13.5	0.74	03:50:00	225.0	0.71	65.5	12.0	0.63
00:34:00	29.0	0.09	73.5	13.9	0.76	03:55:00	230.0	0.72	65.5	12.0	0.63
00:35:00	30.0	0.09	78.0	14.8	0.83	04:10:00	245.0	0.77	67.0	12.3	0.65
00:40:00	35.0	0.11	85.0	16.3	0.95	04:20:00	255.0	0.80	68.5	12.7	0.68
00:45:00	40.0	0.13	84.0	16.1	0.93	04:30:00	265.0	0.83	67.5	12.4	0.66
00:50:00	45.0	0.14	87.5	16.9	0.99	04:40:00	275.0	0.86	69.0	12.8	0.68
00:55:00	50.0	0.16	89.0	17.2	1.01	04:50:00	285.0	0.90	71.0	13.2	0.72
01:00:00	55.0	0.17	86.5	16.7	0.97	05:00:00	295.0	0.93	70.0	13.0	0.70
01:05:00	60.0	0.19	86.5	16.7	0.97	05:15:00	310.0	0.97	71.0	13.2	0.72
02:00:00	115.0	0.36	87.0	16.8	0.98	05:20:00	315.0	0.99	72.0	13.4	0.73
03:00:00	175.0	0.55	88.5	17.1	1.00	05:30:00	325.0	1.02	74.0	13.9	0.77
04:00:00	235.0	0.74	92.0	17.9	1.06	05:40:00	335.0	1.05	73.5	13.8	0.76
05:05:00	300.0	0.94	87.5	16.9	0.99	05:50:00	345.0	1.08	73.5	13.8	0.76
06:00:00	355.0	1.12	87.5	16.9	0.99	06:00:00	355.0	1.12	75.0	14.1	0.78
07:00:00	415.0	1.31	87.5	16.9	0.99	06:15:00	370.0	1.16	76.0	14.3	0.80
08:05:00	480.0	1.51	87.5	16.9	0.99	06:20:00	375.0	1.18	75.5	14.2	0.79
09:00:00	535.0	1.68	87.5	16.9	0.99	06:30:00	385.0	1.21	75.5	14.2	0.79
09:30:00	565.0	1.78	89.0	17.2	1.01	06:40:00	395.0	1.24	76.0	14.3	0.80
						06:50:00	405.0	1.27	76.0	14.3	0.80
						07:00:00	415.0	1.31	77.0	14.6	0.81
						07:10:00	425.0	1.34	77.0	14.6	0.81
						07:20:00	435.0	1.37	78.0	14.8	0.83
						07:30:00	445.0	1.40	78.0	14.8	0.83
						07:40:00	455.0	1.43	78.5	14.9	0.84
						07:50:00	465.0	1.46	79.0	15.0	0.85
						08:00:00	475.0	1.49	79.0	15.0	0.85
						08:10:00	485.0	1.53	81.0	15.4	0.88
						08:20:00	495.0	1.56	81.0	15.4	0.88
						08:30:00	505.0	1.59	81.0	15.4	0.88
						08:40:00	515.0	1.62	81.5	15.6	0.89
						08:50:00	525.0	1.65	81.5	15.6	0.89
						09:00:00	535.0	1.68	82.0	15.7	0.90
						09:15:00	550.0	1.73	81.5	15.6	0.89
						09:20:00	555.0	1.75	82.0	15.7	0.90
						09:27:00	562.0	1.77	81.5	15.6	0.89

Gnrl Eqn: 0.217x-2.096

	(INLET)	(OUTLET)	
Na start:	3.44	3.76	
Na finish:	17.08	17.08	
First condition:	25.5	27.0	(aveage of 3 first samples)
Steady condition:	88.4	88.4	(average of 8 last inlet samples)
			(assumed steady state for Inlet= Outlet)

m= 0.2
b= -2.1

System			Time Correction		Background					
Time In	TOut-TIn	T/Td	C/Co	Time(min)	Time		t/Td	Reading	Conc. Na	C/Co
Eqvl	min.	Td=318			min	min	Td=318		mg/L	
20.0	0.0	0.00	0.00	20.0	00:05:00	0.0	0.00	27.0	3.8	0.0
20.0	0.0	0.00	0.05	22.5	01:00:00	55.0	0.17	27.0	3.8	0.0
20.0	0.0	0.00	0.10	23.0	02:00:00	115.0	0.36	27.0	3.8	0.0
20.0	0.0	0.00	0.15	23.5	03:00:00	175.0	0.55	28.5	4.1	0.0
20.0	0.0	0.00	0.20	24.0	04:00:00	235.0	0.74	27.5	3.9	0.0
20.4	4.6	0.01	0.25	24.0	05:00:00	295.0	0.93	27.5	3.9	0.0
21.6	8.4	0.03	0.30	24.5	06:00:00	355.0	1.12	27.5	3.9	0.0
23.5	11.5	0.04	0.35	25.0	07:00:00	415.0	1.31	27.5	3.9	0.0
24.0	16.0	0.05	0.40	25.5	08:00:00	475.0	1.49	27.5	3.9	0.0
24.0	21.0	0.07	0.45	25.5	09:00:00	535.0	1.68	27.5	3.9	0.0
24.1	25.9	0.08	0.50	26.0	09:30:00	565.0	1.78	28.0	4.0	0.0
24.2	30.8	0.10	0.55	26.0						
24.2	40.8	0.13	0.60	26.5						
24.4	50.6	0.16	0.65	27.0						
24.8	60.2	0.19	0.70	27.5						
25.5	71.5	0.22	0.75	28.0						
25.4	81.6	0.26	0.80	29.0						
25.5	84.5	0.27	0.85	30.0						
25.5	104.5	0.33	0.90	32.0						
25.6	109.4	0.34	0.95	34.0						
26.0	119.0	0.37	1.00	44.0						
26.0	129.0	0.41								
26.0	139.0	0.44								
26.0	144.0	0.45								
26.3	158.7	0.50								
26.4	168.6	0.53								
26.7	178.3	0.56								
26.6	188.4	0.59								
26.8	198.2	0.62								
26.8	203.2	0.64								
27.0	218.0	0.69								
27.3	227.7	0.72								
27.1	237.9	0.75								
27.3	247.7	0.78								
27.7	257.3	0.81								
27.5	267.5	0.84								
27.7	282.3	0.89								
27.8	287.2	0.90								
28.3	296.7	0.93								
28.2	306.8	0.96								
28.2	316.8	1.00								
28.6	326.4	1.03								
29.0	341.0	1.07								
28.8	346.2	1.09								
28.8	356.2	1.12								
29.0	366.0	1.15								
29.0	376.0	1.18								
29.3	385.7	1.21								
29.3	395.7	1.24								
29.6	405.4	1.27								
29.6	415.4	1.31								
29.8	425.2	1.34								
29.9	435.1	1.37								
29.9	445.1	1.40								
31.2	453.8	1.43								
31.2	463.8	1.46								
31.2	473.8	1.49								
31.5	483.5	1.52								
31.5	493.5	1.55								
31.8	503.2	1.58								
31.5	518.5	1.63								
31.8	523.2	1.65								
31.5	530.5	1.67								

SAMPLING NO:	10		
LOCATION:	**Reservoirs 1-2-3**		
FLOW (ML/d):	170		
SAMPLING DATE:	30-Jun-93	until	02-Jul-93
TESTING DATE:	03-Jul-93	and	06-Jul-93
STANDARD MADE:	19-Jun-93		

STANDARDIZATION (BACKGROUND)

mg/L Na	Initial Reading	Final Reading	Average
2.5	18.5	19.0	18.8
5.0	32.5	33.0	32.8
10.0	59.5	59.0	59.3
15.0	80.0	80.0	80.0
17.5	89.5	89.5	89.5
20.0	100.0	100.0	100.0

Regression Statistics

Multiple R	0.998
R Square	0.995
Adjusted R Square	0.994
Standard Error	0.526
Observations	6

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1	244.725	244.725	883.159	0.000
Residual	4	1.108	0.277		
Total	5	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.021	0.508	-3.976	0.011	-3.432	-0.610
x1	0.216	0.007	29.718	0.000	0.196	0.236

STANDARDIZATION (INLET CELL#1)

mg/L Na	Initial Reading	Final Reading	Ave Rdg
2.5	19.5	19.5	19.5
5.0	34.0	33.0	33.5
10.0	60.0	59.0	59.5
15.0	81.0	79.5	80.3
17.5	90.0	88.0	89.0
20.0	100.0	98.0	99.0

Regression Statistics

Multiple R	0.997
R Square	0.995
Adjusted R Square	0.993
Standard Error	0.577
Observations	6.000

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1.000	244.500	244.500	733.384	0.000
Residual	4.000	1.334	0.333		
Total	5.000	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.308	0.567	-4.065	0.010	-3.881	-0.731
x1	0.220	0.008	27.081	0.000	0.198	0.243

STANDARDIZATION (INLET CELL#2)

mg/L Na	Initial Reading	Final Reading	Ave Rdg
2.5	19.0	19.5	19.3
5.0	33.0	34.0	33.5
10.0	59.5	60.5	60.0
15.0	81.5	81.5	81.5
17.5	90.0	91.0	90.5

20.0	100.0	100.0	100.0

Regression Statistics

Multiple R	0.997
R Square	0.994
Adjusted R Square	0.993
Standard Error	0.595
Observations	6.000

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1.000	244.416	244.416	689.936	0.000
Residual	4.000	1.417	0.354		
Total	5.000	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.165	0.580	-3.733	0.014	-3.775	-0.555
x1	0.216	0.008	26.267	0.000	0.193	0.239

STANDARDIZATION (OUTLET CELL#1)

mg/L Na	Initial Reading	Final Reading	Ave Rdg
2.5	19.0	18.0	18.5
5.0	33.0	31.5	32.3
10.0	59.0	58.0	58.5
15.0	79.5	79.5	79.5
17.5	88.0	87.0	87.5
20.0	98.0	98.5	98.3

Regression Statistics

Multiple R	0.997
R Square	0.994
Adjusted R Square	0.993
Standard Error	0.587
Observations	6.000

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1.000	244.457	244.457	710.562	0.000
Residual	4.000	1.376	0.344		
Total	5.000	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.054	0.568	-3.618	0.015	-3.630	-0.478
x1	0.220	0.008	26.656	0.000	0.197	0.243

STANDARDIZATION (OUTLET CELL#2)

mg/L Na	Initial Reading	Final Reading	Ave Rdg
2.5	19.5	19.5	19.5
5.0	33.5	34.0	33.8
10.0	60.0	60.5	60.3
15.0	81.0	81.5	81.3
17.5	90.0	90.5	90.3
20.0	100.0	101.0	100.5

Regression Statistics

Multiple R	0.997
R Square	0.995
Adjusted R Square	0.993
Standard Error	0.573
Observations	6.000

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1.000	244.519	244.519	743.957	0.000
Residual	4.000	1.315	0.329		
Total	5.000	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*

Intercept	-2.229	0.561	-3.975	0.011	-3.785	-0.672
x1	0.216	0.008	27.276	0.000	0.194	0.238

STANDARDIZATION (OUTLET CELL#3)

mg/L Na	Initial Reading	Final Reading	Ave Rdg
2.5	19.0	19.0	19.0
5.0	33.0	33.5	33.3
10.0	59.0	59.5	59.3
15.0	80.5	81.0	80.8
17.5	89.0	89.5	89.3
20.0	100.0	100.0	100.0

Regression Statistics

Multiple R	0.998
R Square	0.995
Adjusted R Square	0.994
Standard Error	0.548
Observations	6.000

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1.000	244.632	244.632	814.684	0.000
Residual	4.000	1.201	0.300		
Total	5.000	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-2.116	0.532	-3.976	0.011	-3.594	-0.639
x1	0.217	0.008	28.543	0.000	0.196	0.238

STANDARDIZATION (OUTLET CONVERGENCE)

mg/L Na	Initial Reading	Final Reading	Ave Rdg
2.5	18.5	18.5	18.5
5.0	32.0	32.5	32.3
10.0	58.5	59.0	58.8
15.0	79.5	80.0	79.8
17.5	89.0	88.5	88.8
20.0	100.0	99.0	99.5

Regression Statistics

Multiple R	0.998
R Square	0.995
Adjusted R Square	0.994
Standard Error	0.527
Observations	6.000

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	1.000	244.721	244.721	879.820	0.000
Residual	4.000	1.113	0.278		
Total	5.000	245.833			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-1.956	0.507	-3.857	0.012	-3.365	-0.548
x1	0.217	0.007	29.662	0.000	0.196	0.237

General Equation:

Background:	y=0.216x-2.021
Inlet Cell 1:	y=0.220x-2.306
Inlet Cell 2:	y=0.216x-2.165
Outlet Cell 1:	y=0.220x-2.054
Outlet Cell 2:	y=0.216x-2.229
Outlet Cell 3:	y=0.217x-2.116
Outlet Converg:	y=0.217x-1.956

TEST NO. 10
RESERVOIR NOS. 1,2,3 (170 ML/d)

Slope:	m=	0.2	m=	0.2
Intercept:	b=	-2.1	b=	-2.3

Gnrl.Eqn:	y=0.220x-2.306	y=0.216x-2.165
	(INLET1)	(INLET2)
Na.back.(mg/L)=	4.44	4.60
Na Final (mg/L)=	18.48	18.32
a Tracer (mg/L)=	14.04	13.72
First condition:	30.67	31.3
Steady condition:	94.5	94.8

Inlet1					Inlet2				
Time		Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co
min	min		mg/L	Initial	min	min		mg/L	Initial
00:05:00	0.0	30.5	4.5	0.00	00:05:00	0.0	31.0	4.4	-0.01
00:06:00	1.0	31.0	4.6	0.01	00:06:00	1.0	31.5	4.6	0.00
00:07:00	2.0	30.5	4.5	0.00	00:07:00	2.0	31.5	4.6	0.00
00:08:00	3.0	31.0	4.6	0.01	00:08:00	3.0	31.5	4.6	0.00
00:09:00	4.0	31.5	4.7	0.01	00:09:00	4.0	31.5	4.6	0.00
00:10:00	5.0	31.0	4.6	0.01	00:10:00	5.0	32.0	4.7	0.01
00:11:00	6.0	32.5	4.9	0.03	00:11:00	6.0	32.0	4.7	0.01
00:12:00	7.0	31.5	4.7	0.01	00:12:00	7.0	31.5	4.6	0.00
00:13:00	8.0	32.0	4.8	0.02	00:13:00	8.0	31.5	4.6	0.00
00:14:00	9.0	33.0	5.0	0.04	00:14:00	9.0	34.0	5.1	0.04
00:15:00	10.0	36.0	5.7	0.08	00:15:00	10.0	33.0	4.9	0.03
00:16:00	11.0	42.5	7.1	0.19	00:16:00	11.0	32.0	4.7	0.01
00:17:00	12.0	48.0	8.3	0.27	00:17:00	12.0	32.0	4.7	0.01
00:18:00	13.0	54.0	9.6	0.37	00:18:00	13.0	32.0	4.7	0.01
00:19:00	14.0	63.0	11.6	0.51	00:19:00	14.0	32.0	4.7	0.01
00:20:00	15.0	68.0	12.6	0.58	00:20:00	15.0	31.5	4.6	0.00
00:21:00	16.0	74.0	13.9	0.68	00:21:00	16.0	32.0	4.7	0.01
00:22:00	17.0	82.0	15.7	0.80	00:22:00	17.0	31.5	4.6	0.00
00:23:00	18.0	85.5	16.4	0.86	00:23:00	18.0	31.5	4.6	0.00
00:24:00	19.0	86.0	16.6	0.87	00:24:00	19.0	31.5	4.6	0.00
00:25:00	20.0	87.0	16.8	0.88	00:25:00	20.0	31.0	4.4	-0.01
00:26:00	21.0	90.0	17.4	0.93	00:26:00	21.0	31.5	4.6	0.00
00:27:00	22.0	93.0	18.1	0.98	00:27:00	22.0	30.0	4.2	-0.02
00:28:00	23.0	94.0	18.3	0.99	00:28:00	23.0	30.0	4.2	-0.02
00:29:00	24.0	94.0	18.3	0.99	00:29:00	24.0	30.0	4.2	-0.02
00:30:00	25.0	95.0	18.5	1.01	00:30:00	25.0	31.0	4.4	-0.01
00:35:00	30.0	94.0	18.3	0.99	00:31:00	26.0	48.0	8.2	0.26
00:40:00	35.0	94.5	18.4	1.00	00:32:00	27.0	80.0	15.2	0.77
00:45:00	40.0	93.5	18.2	0.98	00:33:00	28.0	94.0	18.2	0.99
00:50:00	45.0	95.0	18.5	1.01	00:34:00	29.0	94.5	18.3	0.99
00:55:00	50.0	94.5	18.4	1.00	00:35:00	30.0	95.0	18.4	1.00
01:00:00	55.0	95.5	18.6	1.02	00:36:00	31.0	94.5	18.3	0.99
01:05:00	60.0	95.0	18.5	1.01	00:37:00	32.0	95.0	18.4	1.00
03:10:00	185.0	94.5	18.4	1.00	04:08:00	3123.0	-	-	1.00
04:05:00	240.0	94.5	18.4	1.00					
05:05:00	300.0	93.5	18.2	0.98					
06:05:00	360.0	91.5	17.7	0.95					
07:05:00	420.0	88.0	17.0	0.90					
08:05:00	480.0	95.0	18.5	1.01					
09:05:00	540.0	95.0	18.5	1.01					
10:05:00	600.0	94.5	18.4	1.00					
11:05:00	660.0	94.5	18.4	1.00					
12:05:00	720.0	94.5	18.4	1.00					
13:05:00	780.0	96.0	18.7	1.02					
14:05:00	840.0	95.0	18.5	1.01					
15:05:00	900.0	104.0	20.5	1.15					
16:05:00	960.0	97.0	18.9	1.04					
17:05:00	1020.0	94.5	18.4	1.00					
18:08:00	1083.0	94.0	18.3	0.99					
19:05:00	1140.0	92.0	17.9	0.96					
20:07:00	1202.0	65.0	12.0	0.54					
21:07:00	1262.0	92.0	17.9	0.96					
22:08:00	1323.0	94.5	18.4	1.00					
23:08:00	1383.0	94.5	18.4	1.00					
00:08:00	1443.0	93.5	18.2	0.98					
01:08:00	1503.0	94.5	18.4	1.00					
02:08:00	1563.0	95.0	18.5	1.01					
03:08:00	1623.0	94.5	18.4	1.00					
04:08:00	1683.0	93.0	18.1	0.98					
05:08:00	1743.0	94.0	18.3	0.99					
06:08:00	1803.0	94.0	18.3	0.99					
07:08:00	1863.0	90.5	17.5	0.94					
08:08:00	1923.0	93.5	18.2	0.98					
09:08:00	1983.0	92.0	17.9	0.96					

10:08:00	2043.0	97.0	18.9	1.04
12:08:00	2163.0	94.5	18.4	1.00
13:05:00	2220.0	92.0	17.9	0.96
14:05:00	2280.0	92.5	18.0	0.97
15:05:00	2340.0	93.0	18.1	0.98
16:18:00	2413.0	96.0	18.7	1.02
17:30:00	2485.0	95.0	18.5	1.01
18:02:00	2517.0	95.5	18.6	1.02
18:30:00	2545.0	95.0	18.5	1.01
19:08:00	2583.0	94.5	18.4	1.00
20:08:00	2643.0	94.0	18.3	0.99
21:08:00	2703.0	92.0	17.9	0.96
22:08:00	2763.0	96.5	18.8	1.03
23:08:00	2823.0	94.0	18.3	0.99
00:08:00	2883.0	95.0	18.5	1.01
01:08:00	2943.0	94.0	18.3	0.99
02:08:00	3003.0	94.5	18.4	1.00
03:08:00	3063.0	94.0	18.3	0.99
04:08:00	3123.0	95.0	18.5	1.01

m= 0.2
b= -2.1

y=0.216x-2.021
(BACKGROUND)

4.57
18.46
13.90
30.5
94.8

m= 0.2
b= -2.0

y=0.220x-2.054
(OUTLET1)

4.66
18.85
14.19
30.5
95.0

Background					Outlet1				
Time		Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co
min	min		mg/L		min	min		mg/L	
00:05:00	0.0	30.5	4.5	0.00	01:58:00	113.0	30.5	4.5	0.00
01:05:00	60.0	30.5	4.5	0.00	02:18:00	133.0	31.0	4.6	0.01
02:30:00	145.0	30.5	4.5	0.00	02:38:00	153.0	33.5	5.2	0.05
03:05:00	180.0	30.5	4.5	0.00	02:58:00	173.0	40.0	6.6	0.15
04:05:00	240.0	30.5	4.5	0.00	03:18:00	193.0	41.5	6.9	0.17
05:05:00	300.0	30.5	4.5	0.00	03:38:00	213.0	43.0	7.2	0.19
06:05:00	360.0	30.5	4.5	0.00	03:58:00	233.0	48.0	8.5	0.29
07:05:00	420.0	30.5	4.5	0.00	04:18:00	253.0	51.0	8.9	0.32
08:05:00	480.0	31.5	4.7	0.02	04:38:00	273.0	53.0	9.4	0.35
09:05:00	540.0	31.5	4.7	0.02	04:58:00	293.0	48.0	8.3	0.27
09:50:00	585.0	31.5	4.7	0.02	05:18:00	313.0	61.0	11.1	0.47
11:05:00	660.0	31.5	4.7	0.02	05:38:00	333.0	58.0	10.4	0.43
11:57:00	712.0	31.5	4.7	0.02	05:58:00	353.0	61.0	11.1	0.47
13:05:00	780.0	31.5	4.7	0.02	06:18:00	373.0	62.5	11.4	0.50
13:57:00	832.0	31.5	4.7	0.02	06:38:00	393.0	62.5	11.4	0.50
15:00:00	895.0	32.0	4.8	0.02	06:58:00	413.0	64.0	11.7	0.52
16:00:00	955.0	34.0	5.3	0.05	07:18:00	433.0	69.0	12.8	0.60
17:05:00	1020.0	31.5	4.7	0.02	07:38:00	453.0	69.0	12.8	0.60
18:05:00	1080.0	34.0	5.3	0.05	07:58:00	473.0	69.5	12.9	0.60
18:57:00	1132.0	32.0	4.8	0.02	08:18:00	493.0	73.0	13.7	0.66
19:57:00	1192.0	30.5	4.5	0.00	08:38:00	513.0	74.0	13.9	0.67
20:53:00	1248.0	30.5	4.5	0.00	08:58:00	533.0	75.0	14.1	0.69
21:52:00	1307.0	30.5	4.5	0.00	09:18:00	553.0	75.0	14.1	0.69
22:50:00	1365.0	32.0	4.8	0.02	09:38:00	573.0	76.0	14.3	0.71
23:50:00	1425.0	32.5	5.0	0.03	12:20:00	735.0	82.0	15.6	0.80
00:50:00	1485.0	40.5	6.7	0.15	12:50:00	765.0	83.0	15.8	0.81
01:50:00	1545.0	35.0	5.5	0.07	13:19:00	794.0	84.5	16.1	0.84
04:05:00	1680.0	30.0	4.4	-0.01	13:48:00	823.0	85.0	16.2	0.84
05:05:00	1740.0	30.0	4.4	-0.01	14:08:00	843.0	86.0	16.5	0.86
06:05:00	1800.0	30.0	4.4	-0.01	14:27:00	862.0	86.0	16.5	0.86
07:05:00	1860.0	30.5	4.5	0.00	14:28:00	863.0	87.0	16.7	0.88
08:05:00	1920.0	30.0	4.4	-0.01	14:48:00	883.0	87.0	16.7	0.88
09:05:00	1980.0	30.0	4.4	-0.01	15:08:00	903.0	87.0	16.7	0.88
10:05:00	2040.0	30.0	4.4	-0.01	15:28:00	923.0	89.0	17.1	0.91
11:05:00	2100.0	60.0	10.9	0.46	15:48:00	943.0	89.0	17.1	0.91
11:49:00	2144.0	30.0	4.4	-0.01	16:08:00	963.0	89.0	17.1	0.91
12:37:00	2192.0	29.5	4.3	-0.02	16:28:00	983.0	89.5	17.2	0.91
13:21:00	2236.0	30.0	4.4	-0.01	16:48:00	1003.0	90.0	17.3	0.92
15:05:00	2340.0	29.5	4.3	-0.02	17:08:00	1023.0	91.5	17.6	0.95
18:50:00	2565.0	29.5	4.3	-0.02	17:28:00	1043.0	91.5	17.6	0.95
19:52:00	2627.0	29.5	4.3	-0.02	17:55:00	1070.0	91.0	17.5	0.94
20:00:00	2635.0	29.5	4.3	-0.02	18:08:00	1083.0	91.5	17.6	0.95
20:50:00	2685.0	29.5	4.3	-0.02	17:55:00	1070.0	91.0	17.5	0.94
21:50:00	2745.0	29.5	4.3	-0.02	18:35:00	1110.0	91.5	17.6	0.95
22:50:00	2805.0	29.5	4.3	-0.02	19:17:00	1152.0	91.0	17.5	0.94
23:50:00	2865.0	29.5	4.3	-0.02	19:17:00	1152.0	92.0	17.8	0.95
00:51:00	2926.0	30.0	4.4	-0.01	19:37:00	1172.0	92.0	17.8	0.95
01:50:00	2985.0	29.5	4.3	-0.02	19:59:00	1194.0	92.5	17.9	0.96
02:50:00	3045.0	29.5	4.3	-0.02	20:17:00	1212.0	93.0	18.0	0.97
03:50:00	3105.0	30.0	4.4	-0.01	20:37:00	1232.0	92.5	17.9	0.96
					20:57:00	1252.0	93.0	18.0	0.97
					21:17:00	1272.0	92.5	17.9	0.96
					21:37:00	1292.0	93.5	18.1	0.98
					21:57:00	1312.0	93.0	18.0	0.97
					22:17:00	1332.0	93.0	18.0	0.97
					22:37:00	1352.0	93.0	18.0	0.97
					22:57:00	1372.0	92.5	17.9	0.96
					23:17:00	1392.0	94.0	18.2	0.98
					23:37:00	1412.0	93.5	18.1	0.98
					23:57:00	1432.0	93.5	18.1	0.98
					00:17:00	1452.0	93.5	18.1	0.98
					00:37:00	1472.0	94.0	18.2	0.98
					00:57:00	1492.0	93.5	18.1	0.98
					01:17:00	1512.0	93.5	18.1	0.98

01:37:00	1532.0	94.0	18.2	0.98
01:57:00	1552.0	94.5	18.3	0.99
02:17:00	1572.0	94.5	18.3	0.99
02:37:00	1592.0	93.5	18.1	0.98
02:57:00	1612.0	94.0	18.2	0.98
03:17:00	1632.0	94.5	18.3	0.99
03:37:00	1652.0	94.5	18.3	0.99
03:57:00	1672.0	95.0	18.4	1.00
04:17:00	1692.0	95.0	18.4	1.00
04:37:00	1712.0	94.5	18.3	0.99
04:57:00	1732.0	94.5	18.3	0.99
05:17:00	1752.0	95.0	18.4	1.00
05:37:00	1772.0	95.0	18.4	1.00
05:57:00	1792.0	95.0	18.4	1.00
06:17:00	1812.0	95.0	18.4	1.00
06:37:00	1832.0	95.0	18.4	1.00
06:57:00	1852.0	95.0	18.4	1.00
07:17:00	1872.0	94.5	18.3	0.99
07:37:00	1892.0	94.5	18.3	0.99
07:57:00	1912.0	94.5	18.3	0.99
08:17:00	1932.0	95	18.4	1.00
08:37:00	1952.0	95	18.4	1.00
08:57:00	1972.0	95	18.4	1.00
09:17:00	1992.0	95	18.4	1.00
09:37:00	2012.0	95	18.4	1.00
09:57:00	2032.0	95.5	18.5	1.01
10:17:00	2052.0	95	18.4	1.00
10:37:00	2072.0	95.5	18.5	1.01
10:57:00	2092.0	95	18.4	1.00
11:17:00	2112.0	95	18.4	1.00
11:37:00	2132.0	95	18.4	1.00
11:57:00	2152.0	95	18.4	1.00
12:00:00	2155.0	95	18.4	1.00
12:17:00	2172.0	95	18.4	1.00
12:42:00	2197.0	95	18.4	1.00
00:57:00	1492.0	95	18.4	1.00
13:18:00	2233.0	95	18.4	1.00
13:44:00	2259.0	94.5	18.3	0.99
13:59:00	2274.0	95	18.4	1.00
14:59:00	2334.0	95	18.4	1.00
15:20:00	2355.0	95	18.4	1.00
15:30:00	2365.0	94	18.2	0.98
16:15:00	2410.0	95	18.4	1.00
16:45:00	2440.0	95	18.4	1.00
17:28:00	2483.0	95	18.4	1.00
17:58:00	2513.0	95	18.4	1.00
18:23:00	2538.0	95	18.4	1.00
18:37:00	2552.0	95	18.4	1.00
18:57:00	2572.0	95	18.4	1.00
19:17:00	2592.0	95.5	18.5	1.01
19:37:00	2612.0	95	18.4	1.00
19:57:00	2632.0	95	18.4	1.00
20:17:00	2652.0	95	18.4	1.00
20:37:00	2672.0	95	18.4	1.00
20:57:00	2692.0	95	18.4	1.00
21:17:00	2712.0	94.5	18.3	0.99
21:37:00	2732.0	95	18.4	1.00
21:57:00	2752.0	95	18.4	1.00
22:17:00	2772.0	94.5	18.3	0.99
22:37:00	2792.0	95	18.4	1.00
22:57:00	2812.0	94.5	18.3	0.99
23:17:00	2832.0	95	18.4	1.00
23:37:00	2852.0	95	18.4	1.00
23:57:00	2872.0	95	18.4	1.00
00:17:00	2892.0	95	18.4	1.00
00:37:00	2912.0	95	18.4	1.00
00:57:00	2932.0	95.5	18.5	1.01
01:17:00	2952.0	95	18.4	1.00
01:37:00	2972.0	95	18.4	1.00
01:57:00	2992.0	95	18.4	1.00
02:17:00	3012.0	95	18.4	1.00
02:37:00	3032.0	95	18.4	1.00
02:57:00	3052.0	95	18.4	1.00
03:17:00	3072.0	95	18.4	1.00

m= 0.2
b= -2.3

m= 0.2
b= -2.2

y=0.216x-2.229
(OUTLET2)

4.50
18.18
13.68
31.2
94.5

y=0.217x-2.116
(OUTLET3)

4.54
18.28
13.74
30.7
94.0

Outlet2					Outlet3				
Time		Reading	Conc. Na	C/Co	Time		Reading	Conc. Na	C/Co
min	min		mg/L		min	min		mg/L	
00:05:00	0.0	31.0	4.5	0.00	00:05:00	0.0	30.5	4.5	0.00
00:10:00	5.0	31.5	4.6	0.01	00:10:00	5.0	30.5	4.5	0.00
00:15:00	10.0	31.0	4.5	0.00	00:15:00	10.0	31.0	4.6	0.01
00:20:00	15.0	31.0	4.5	0.00	00:20:00	15.0	30.5	4.5	0.00
00:25:00	20.0	31.5	4.6	0.01	00:25:00	20.0	31.0	4.6	0.01
00:30:00	25.0	31.0	4.5	0.00	00:30:00	25.0	31.0	4.6	0.01
00:35:00	30.0	31.5	4.6	0.01	00:35:00	30.0	31.0	4.6	0.01
00:40:00	35.0	31.5	4.6	0.01	00:40:00	35.0	31.0	4.6	0.01
00:50:00	45.0	32.0	4.7	0.01		67.5			0.00
01:00:00	55.0	32.5	4.8	0.02	01:45:00	100.0	47.0	8.1	0.26
01:05:00	60.0	33.0	4.9	0.03	01:50:00	105.0	47.0	8.1	0.26
01:10:00	65.0	36.0	5.6	0.08	02:10:00	125.0	47.5	8.2	0.27
01:15:00	70.0	43.0	7.1	0.19	02:40:00	155.0	45.5	7.8	0.23
01:20:00	75.0	42.0	6.9	0.17	03:00:00	175.0	49.0	8.5	0.29
01:25:00	80.0	42.5	7.0	0.18	03:15:00	190.0	48.5	8.4	0.28
01:30:00	85.0	45.0	7.6	0.22	03:20:00	195.0	48.5	8.4	0.28
01:35:00	90.0	47.0	8.0	0.25	03:40:00	215.0	49.0	8.5	0.29
01:50:00	105.0	49.0	8.4	0.28	04:00:00	235.0	48.5	8.4	0.28
02:10:00	125.0	51.0	8.9	0.31	04:20:00	255.0	51.5	9.1	0.33
02:32:00	147.0	51.5	9.0	0.32	04:40:00	275.0	53.0	9.4	0.35
02:54:00	169.0	50.5	8.8	0.31	05:00:00	295.0	55.0	9.9	0.38
03:16:00	191.0	51.0	8.9	0.31	05:20:00	315.0	55.0	9.9	0.38
03:38:00	213.0	50.5	8.8	0.31	05:40:00	335.0	58.5	10.6	0.44
04:00:00	235.0	52.0	9.1	0.33	06:00:00	355.0	64.0	11.8	0.53
04:22:00	257.0	56.5	10.1	0.40	09:59:00	594.0	63.5	11.7	0.52
04:44:00	279.0	59.0	10.6	0.44	10:23:00	618.0	64.5	11.9	0.53
05:06:00	301.0	61.0	11.1	0.47	10:47:00	642.0	65.5	12.2	0.55
05:28:00	323.0	59.5	10.7	0.45	11:11:00	666.0	65.5	12.2	0.55
05:50:00	345.0	61.0	11.1	0.47	11:35:00	690.0	66.5	12.4	0.57
06:12:00	367.0	62.0	11.3	0.49	11:59:00	714.0	67.0	12.5	0.57
06:34:00	389.0	62.5	11.4	0.49	12:23:00	738.0	68.0	12.7	0.59
06:56:00	411.0	66.5	12.3	0.56	12:47:00	762.0	69.0	12.9	0.61
07:18:00	433.0	65.5	12.0	0.54	13:11:00	786.0	70.5	13.3	0.63
07:40:00	455.0	67.0	12.4	0.57	13:35:00	810.0	71.0	13.4	0.64
08:02:00	477.0	68.0	12.6	0.58	13:59:00	834.0	71.0	13.4	0.64
08:24:00	499.0	69.5	12.9	0.61	14:23:00	858.0	71.0	13.4	0.64
08:46:00	521.0	69.5	12.9	0.61	14:47:00	882.0	72.0	13.6	0.65
09:08:00	543.0	69.5	12.9	0.61	15:11:00	906.0	71.5	13.5	0.64
09:30:00	565.0	70.0	13.0	0.61	15:35:00	930.0	74.0	14.0	0.68
09:52:00	587.0	70.5	13.1	0.62	15:59:00	954.0	73.5	13.9	0.68
10:39:00	634.0	83.0	15.9	0.82	16:23:00	978.0	74.5	14.1	0.69
10:59:00	654.0	72.0	13.5	0.64	16:47:00	1002.0	75.0	14.2	0.70
11:19:00	674.0	77.0	14.6	0.72	17:11:00	1026.0	75.0	14.2	0.70
11:39:00	694.0	75.5	14.2	0.70	17:35:00	1050.0	75.0	14.2	0.70
11:59:00	714.0	75.5	14.2	0.70	17:59:00	1074.0	73.5	13.9	0.68
12:19:00	734.0	78.0	14.8	0.74	18:23:00	1098.0	75.0	14.2	0.70
12:39:00	754.0	76.0	14.3	0.71	18:56:00	1131.0	75.5	14.3	0.71
12:59:00	774.0	76.0	14.3	0.71	19:17:00	1152.0	76.0	14.5	0.72
13:19:00	794.0	77.0	14.6	0.72	19:38:00	1173.0	77.0	14.7	0.73
13:39:00	814.0	78.5	14.9	0.75	19:59:00	1194.0	77.0	14.7	0.73
13:59:00	834.0	79.0	15.0	0.76	20:20:00	1215.0	77.5	14.8	0.74
14:19:00	854.0	79.0	15.0	0.76	20:41:00	1236.0	78.0	14.9	0.75
14:39:00	874.0	79.5	15.1	0.76	21:02:00	1257.0	73.0	13.8	0.67
14:59:00	894.0	78.0	14.8	0.74	21:23:00	1278.0	76.0	14.5	0.72
15:19:00	914.0	79.0	15.0	0.76	21:44:00	1299.0	77.5	14.8	0.74
15:39:00	934.0	81.0	15.4	0.79	22:05:00	1320.0	78.0	14.9	0.75
15:59:00	954.0	82.0	15.7	0.80	22:26:00	1341.0	78.5	15.0	0.76
16:19:00	974.0	81.0	15.4	0.79	22:47:00	1362.0	79.0	15.1	0.76
16:39:00	994.0	81.5	15.6	0.79	23:08:00	1383.0	80.0	15.3	0.78
16:59:00	1014.0	82.5	15.8	0.81	23:29:00	1404.0	82.5	15.9	0.82
17:19:00	1034.0	83.0	15.9	0.82	23:50:00	1425.0	81.0	15.6	0.79
17:39:00	1054.0	83.0	15.9	0.82	00:11:00	1446.0	81.0	15.6	0.79
19:35:00	1170.0	84.5	16.2	0.84	00:32:00	1467.0	79.5	15.2	0.77
20:55:00	1250.0	85.0	16.3	0.85	00:53:00	1488.0	79.5	15.2	0.77

21:15:00	1270.0	87.0	16.8	0.88
21:35:00	1290.0	85.0	16.3	0.85
21:55:00	1310.0	79.0	15.0	0.76
22:15:00	1330.0	82.0	15.7	0.80
22:35:00	1350.0	85.0	16.3	0.85
22:55:00	1370.0	86.0	16.5	0.87
23:15:00	1390.0	86.5	16.6	0.87
23:35:00	1410.0	85.0	16.3	0.85
23:55:00	1430.0	87.0	16.8	0.88
00:15:00	1450.0	87.0	16.8	0.88
00:35:00	1470.0	86.0	16.5	0.87
00:55:00	1490.0	88.0	17.0	0.90
02:30:00	1585.0	91.0	17.6	0.94
02:50:00	1605.0	90.0	17.4	0.93
03:10:00	1625.0	90.5	17.5	0.94
03:30:00	1645.0	89.5	17.3	0.92
03:50:00	1665.0	89.5	17.3	0.92
04:10:00	1685.0	89	17.2	0.91
04:30:00	1705.0	90	17.4	0.93
05:10:00	1745.0	89.5	17.3	0.92
05:30:00	1765.0	89.5	17.3	0.92
05:50:00	1785.0	90	17.4	0.93
06:10:00	1805.0	90	17.4	0.93
06:30:00	1825.0	90	17.4	0.93
06:50:00	1845.0	90	17.4	0.93
07:10:00	1865.0	90	17.4	0.93
07:30:00	1885.0	90	17.4	0.93
07:50:00	1905.0	91	17.6	0.94
08:10:00	1925.0	90	17.4	0.93
08:30:00	1945.0	90	17.4	0.93
09:30:00	2005.0	91	17.6	0.94
09:50:00	2025.0	91	17.6	0.94
10:10:00	2045.0	91	17.6	0.94
11:24:00	2119.0	86	16.5	0.87
11:44:00	2139.0	92	17.9	0.96
12:04:00	2159.0	92	17.9	0.96
12:24:00	2179.0	91	17.6	0.94
12:44:00	2199.0	92	17.9	0.96
13:04:00	2219.0	91.5	17.7	0.95
13:24:00	2239.0	92.5	18.0	0.97
13:44:00	2259.0	92.5	18.0	0.97
14:04:00	2279.0	95	18.5	1.01
18:26:00	2541.0	93.5	18.2	0.98
18:54:00	2569.0	94	18.3	0.99
19:14:00	2589.0	94.5	18.4	1.00
19:34:00	2609.0	94.5	18.4	1.00
19:54:00	2629.0	94.5	18.4	1.00
20:14:00	2649.0	94	18.3	0.99
20:34:00	2669.0	94.5	18.4	1.00
20:54:00	2689.0	95	18.5	1.01
21:14:00	2709.0	95	18.5	1.01
21:34:00	2729.0	94.5	18.4	1.00
21:54:00	2749.0	94.5	18.4	1.00
22:14:00	2769.0	95	18.5	1.01
22:34:00	2789.0	95	18.5	1.01
22:54:00	2809.0	94.5	18.4	1.00
23:14:00	2829.0	95	18.5	1.01
23:34:00	2849.0	94.5	18.4	1.00
23:54:00	2869.0	94.5	18.4	1.00
00:14:00	2889.0	94.5	18.4	1.00
00:34:00	2909.0	94.5	18.4	1.00
04:00:00	3115.0	94.5	18.4	1.00

01:14:00	1509.0	81.0	15.6	0.79
01:45:00	1540.0	81.5	15.7	0.80
02:05:00	1560.0	81.5	15.7	0.80
02:25:00	1580.0	83.0	16.0	0.83
02:45:00	1600.0	82.0	15.8	0.81
03:05:00	1620.0	83.0	16.0	0.83
03:25:00	1640.0	83.5	16.1	0.83
03:45:00	1660.0	81.5	15.7	0.80
04:05:00	1680.0	83.0	16.0	0.83
04:25:00	1700.0	84.0	16.2	0.84
04:45:00	1720.0	83.5	16.1	0.83
05:05:00	1740.0	83.0	16.0	0.83
05:25:00	1760.0	82.0	15.8	0.81
05:45:00	1780.0	84.5	16.3	0.85
06:05:00	1800.0	84.0	16.2	0.84
06:25:00	1820.0	83.5	16.1	0.83
06:45:00	1840.0	84.0	16.2	0.84
07:05:00	1860.0	84.0	16.2	0.84
07:25:00	1880.0	85.0	16.4	0.86
07:45:00	1900.0	85.0	16.4	0.86
08:05:00	1920.0	86.0	16.6	0.87
08:25:00	1940.0	85.5	16.5	0.87
08:45:00	1960.0	86.0	16.6	0.87
10:47:00	2082.0	86.0	16.6	0.87
11:07:00	2102.0	87.0	16.9	0.89
11:27:00	2122.0	88.0	17.1	0.91
11:47:00	2142.0	88.0	17.1	0.91
12:07:00	2162.0	90.0	17.5	0.94
12:27:00	2182.0	89.5	17.4	0.93
12:47:00	2202.0	90.0	17.5	0.94
13:07:00	2222.0	89.5	17.4	0.93
13:27:00	2242.0	90.0	17.5	0.94
13:47:00	2262.0	89.5	17.4	0.93
14:07:00	2282.0	91.0	17.7	0.95
14:27:00	2302.0	90.5	17.6	0.94
14:47:00	2322.0	90.5	17.6	0.94
15:07:00	2342.0	91.0	17.7	0.95
15:27:00	2362.0	91.0	17.7	0.95
15:47:00	2382.0	91.5	17.9	0.96
16:07:00	2402.0	90.5	17.6	0.94
16:27:00	2422.0	91.0	17.7	0.95
16:47:00	2442.0	91.5	17.9	0.96
17:07:00	2462.0	94.0	18.4	1.00
18:17:00	2532.0	92.0	18.0	0.97
18:37:00	2552.0	91.0	17.7	0.95
18:57:00	2572.0	91.0	17.7	0.95
19:17:00	2592.0	92.0	18.0	0.97
19:37:00	2612.0	91.5	17.9	0.96
19:57:00	2632.0	92.0	18.0	0.97
20:17:00	2652.0	91.5	17.9	0.96
20:37:00	2672.0	92.0	18.0	0.97
20:57:00	2692.0	92.0	18.0	0.97
21:17:00	2712.0	92.5	18.1	0.98
21:37:00	2732.0	93.0	18.2	0.98
21:57:00	2752.0	92.5	18.1	0.98
22:17:00	2772.0	92.5	18.1	0.98
22:37:00	2792.0	93.0	18.2	0.98
22:57:00	2812.0	93.0	18.2	0.98
23:17:00	2832.0	92.5	18.1	0.98
23:37:00	2852.0	93.0	18.2	0.98
23:57:00	2872.0	93.0	18.2	0.98
00:17:00	2892.0	93.5	18.3	0.99
00:37:00	2912.0	93.5	18.3	0.99
01:52:00	2987.0	94.5	18.5	1.01
02:12:00	3007.0	94.0	18.4	1.00
02:30:00	3025.0	94.0	18.4	1.00
03:20:00	3075.0	94.0	18.4	1.00

m= 0.2
b= -2.0

y=0.217x-1.956
(CONVERGENCE)

4.59
18.55
13.96

30.2
94.5

(AVERAGE FROM INLET 1& 2)

4.52
18.40
13.88

Convergence					
Time		T/Td	Reading	Conc. Na	C/Co
min	min	Td=926		mg/L	
00:05:00	0.0	0.00	38.5	4.6	0.01
00:15:00	10.0	0.01	38.0	4.5	0.00
00:25:00	20.0	0.02	38.0	4.5	0.00
00:35:00	30.0	0.03	38.0	4.5	0.00
00:45:00	40.0	0.04	38.5	4.6	0.01
00:55:00	50.0	0.05	38.5	4.6	0.01
01:05:00	60.0	0.06	38.5	4.6	0.01
01:17:00	72.0	0.08	38.0	4.5	0.00
01:25:00	80.0	0.09	38.5	4.6	0.01
01:35:00	90.0	0.10	38.0	4.5	0.00
01:45:00	100.0	0.11	38.0	4.5	0.00
02:01:00	116.0	0.13	39.0	5.1	0.04
02:05:00	120.0	0.13	38.5	5.0	0.04
02:15:00	130.0	0.14	39.0	5.6	0.08
02:25:00	140.0	0.15	39.0	6.0	0.11
02:35:00	150.0	0.16	38.0	5.8	0.09
02:45:00	160.0	0.17	39.5	6.1	0.11
02:55:00	170.0	0.18	39.5	6.1	0.11
03:05:00	180.0	0.19	39.5	6.1	0.11
03:15:00	190.0	0.21	38.5	5.9	0.10
03:25:00	200.0	0.22	39.0	6.4	0.14
03:35:00	210.0	0.23	39.0	6.4	0.14
03:45:00	220.0	0.24	42.0	7.3	0.18
03:55:00	230.0	0.25	42.0	7.3	0.20
04:05:00	240.0	0.26	42.0	7.3	0.20
04:15:00	250.0	0.27	44.0	7.3	0.22
04:25:00	260.0	0.28	44.5	7.6	0.22
04:35:00	270.0	0.29	45.0	7.7	0.23
04:45:00	280.0	0.30	45.0	7.7	0.23
04:55:00	290.0	0.31	48.0	8.4	0.28
05:05:00	300.0	0.32	48.0	8.4	0.28
05:15:00	310.0	0.33	49.0	8.6	0.29
05:25:00	320.0	0.35	49.0	8.6	0.29
05:35:00	330.0	0.36	52.0	9.2	0.34
05:45:00	340.0	0.37	52.0	9.2	0.34
05:55:00	350.0	0.38	53.0	9.9	0.39
06:05:00	360.0	0.39	53.5	10.0	0.39
06:15:00	370.0	0.40	53.0	9.9	0.39
06:25:00	380.0	0.41	53.0	9.9	0.39
06:35:00	390.0	0.42	54.5	10.2	0.41
06:45:00	400.0	0.43	54.0	10.5	0.43
06:55:00	410.0	0.44	54.0	10.5	0.43
07:05:00	420.0	0.45	54.5	10.6	0.44
07:15:00	430.0	0.46	54.0	10.5	0.43
07:25:00	440.0	0.48	54.0	10.5	0.43
07:35:00	450.0	0.49	54.5	10.6	0.44
07:45:00	460.0	0.50	54.0	10.5	0.43
07:55:00	470.0	0.51	56.0	11.1	0.47
08:05:00	480.0	0.52	57.0	11.2	0.48
08:15:00	490.0	0.53	58.5	11.5	0.50
08:25:00	500.0	0.54	58.0	11.4	0.49
08:35:00	510.0	0.55	58.5	11.5	0.50
08:45:00	520.0	0.56	59.0	11.6	0.51
08:55:00	530.0	0.57	59.5	11.7	0.52
09:05:00	540.0	0.58	60.0	11.8	0.53
09:15:00	550.0	0.59	59.0	11.6	0.51
09:25:00	560.0	0.60	59.5	11.7	0.52
09:35:00	570.0	0.62	60.0	11.8	0.53
09:45:00	580.0	0.63	60.5	12.0	0.54
09:55:00	590.0	0.64	61.0	12.7	0.59
10:05:00	600.0	0.65	61.5	12.9	0.60
10:15:00	610.0	0.66	61.5	13.0	0.61
10:25:00	620.0	0.67	61.5	13.0	0.61
10:35:00	630.0	0.68	61.5	13.0	0.61

10:45:00	640.0	0.69	69.5	13.0	0.61
10:55:00	650.0	0.70	70.0	13.1	0.62
11:06:00	661.0	0.71	70.5	13.2	0.63
11:18:00	673.0	0.73	70.5	13.2	0.63
11:27:00	682.0	0.74	71.0	13.3	0.63
11:35:00	690.0	0.75	71.0	13.3	0.63
11:45:00	700.0	0.76	72.0	13.5	0.65
11:55:00	710.0	0.77	72.0	13.5	0.65
12:06:00	721.0	0.78	71.5	13.4	0.64
12:18:00	733.0	0.79	73.0	13.8	0.67
12:28:00	743.0	0.80	74.0	14.0	0.68
12:35:00	750.0	0.81	74.0	14.0	0.68
12:45:00	760.0	0.82	74.5	14.1	0.69
12:55:00	770.0	0.83	75.0	14.2	0.70
13:05:00	780.0	0.84	75.0	14.2	0.70
13:15:00	790.0	0.85	75.5	14.3	0.70
13:25:00	800.0	0.86	76.0	14.4	0.71
13:35:00	810.0	0.87	76.0	14.4	0.71
13:45:00	820.0	0.89	76.0	14.4	0.71
13:55:00	830.0	0.90	76.5	14.5	0.72
14:05:00	840.0	0.91	77.0	14.6	0.73
14:15:00	850.0	0.92	76.0	14.4	0.71
14:25:00	860.0	0.93	78.0	14.8	0.74
14:35:00	870.0	0.94	78.0	14.8	0.74
14:45:00	880.0	0.95	77.0	14.6	0.73
14:55:00	890.0	0.96	78.0	14.8	0.74
15:05:00	900.0	0.97	79.5	15.2	0.77
15:25:00	920.0	0.99	81.0	15.5	0.79
15:35:00	930.0	1.00	81.0	15.5	0.79
15:45:00	940.0	1.02	80.0	15.3	0.77
15:55:00	950.0	1.03	80.5	15.4	0.78
16:05:00	960.0	1.04	81.0	15.5	0.79
16:15:00	970.0	1.05	81.0	15.5	0.79
16:25:00	980.0	1.06	81.0	15.5	0.79
16:35:00	990.0	1.07	82.0	15.7	0.81
16:45:00	1000.0	1.08	83.0	15.9	0.82
16:55:00	1010.0	1.09	83.0	15.9	0.82
17:05:00	1020.0	1.10	83.0	15.9	0.82
17:15:00	1030.0	1.11	83.0	15.9	0.82
17:25:00	1040.0	1.12	83.5	16.0	0.83
17:35:00	1050.0	1.13	83.0	15.9	0.82
17:45:00	1060.0	1.14	84.0	16.1	0.84
17:55:00	1070.0	1.16	85.0	16.4	0.85
18:05:00	1080.0	1.17	85.0	16.4	0.85
18:15:00	1090.0	1.18	83.5	16.0	0.83
18:25:00	1100.0	1.19	84.0	16.1	0.84
18:35:00	1110.0	1.20	84.0	16.1	0.84
18:45:00	1120.0	1.21	84.5	16.2	0.84
18:55:00	1130.0	1.22	85.0	16.4	0.85
19:05:00	1140.0	1.23	84.0	16.1	0.84
19:15:00	1150.0	1.24	83.5	16.0	0.83
19:25:00	1160.0	1.25	85.0	16.4	0.85
19:35:00	1170.0	1.26	84.0	16.1	0.84
19:45:00	1180.0	1.27	85.0	16.4	0.85
19:55:00	1190.0	1.29	84.0	16.1	0.84
20:05:00	1200.0	1.30	85.0	16.4	0.85
20:15:00	1210.0	1.31	85.5	16.5	0.86
20:25:00	1220.0	1.32	86.5	16.7	0.88
20:35:00	1230.0	1.33	87.0	16.8	0.88
20:45:00	1240.0	1.34	87.0	16.8	0.88
20:55:00	1250.0	1.35	86.0	16.6	0.87
21:05:00	1260.0	1.36	86.5	16.7	0.88
21:15:00	1270.0	1.37	86.0	16.6	0.87
21:25:00	1280.0	1.38	85.0	16.4	0.85
21:35:00	1290.0	1.39	85.0	16.4	0.85
21:45:00	1300.0	1.40	85.0	16.4	0.85
21:55:00	1310.0	1.41	86.0	16.6	0.87
22:05:00	1320.0	1.43	86.5	16.7	0.88
22:15:00	1330.0	1.44	86.5	16.7	0.88
22:25:00	1340.0	1.45	87.0	16.8	0.88
22:35:00	1350.0	1.46	87.0	16.8	0.88
22:45:00	1360.0	1.47	87.0	16.8	0.88
22:55:00	1370.0	1.48	87.0	16.8	0.88
23:05:00	1380.0	1.49	87.0	16.8	0.88
23:15:00	1390.0	1.50	87.0	16.8	0.88
23:25:00	1400.0	1.51	87.0	16.8	0.88
23:35:00	1410.0	1.52	87.0	16.8	0.88
23:45:00	1420.0	1.53	87.0	16.8	0.88
23:55:00	1430.0	1.54	87.0	16.8	0.88
00:05:00	1440.0	1.56	88.0	17.0	0.90
00:15:00	1450.0	1.57	88.0	17.0	0.90
00:25:00	1460.0	1.58	87.0	16.8	0.88
00:35:00	1470.0	1.59	87.0	16.8	0.88
00:45:00	1480.0	1.60	88.0	17.0	0.90

00:55:00	1490.0	1.61	97.5	16.9	0.89
01:05:00	1500.0	1.62	97.5	16.9	0.89
01:15:00	1510.0	1.63	97.0	16.8	0.88
01:25:00	1520.0	1.64	97.5	16.9	0.89
01:35:00	1530.0	1.65	98.0	17.0	0.90
01:45:00	1540.0	1.66	98.0	17.0	0.90
01:55:00	1550.0	1.67	98.0	17.2	0.91
02:05:00	1560.0	1.68	98.0	17.2	0.91
02:15:00	1570.0	1.70	98.0	17.0	0.90
02:25:00	1580.0	1.71	98.5	17.1	0.91
02:35:00	1590.0	1.72	98.0	17.2	0.91
02:45:00	1600.0	1.73	98.0	17.2	0.91
02:55:00	1610.0	1.74	98.0	17.2	0.91
03:05:00	1620.0	1.75	98.0	17.2	0.91
03:25:00	1640.0	1.77	98.0	17.4	0.93
03:35:00	1650.0	1.78	98.0	17.4	0.93
03:45:00	1660.0	1.79	98.0	17.3	0.92
03:55:00	1670.0	1.80	98.5	17.3	0.92
04:05:00	1680.0	1.81	98.5	17.3	0.92
04:15:00	1690.0	1.83	98.5	17.3	0.92
04:25:00	1700.0	1.84	98.0	17.0	0.90
04:35:00	1710.0	1.85	98.0	17.2	0.91
04:45:00	1720.0	1.86	98.0	17.4	0.93
04:53:00	1730.0	1.87	98.0	17.4	0.93
05:05:00	1740.0	1.88	98.0	17.4	0.93
05:15:00	1750.0	1.89	98.5	17.3	0.92
05:25:00	1760.0	1.90	98.5	17.3	0.92
05:35:00	1770.0	1.91	98.5	17.3	0.92
05:45:00	1780.0	1.92	98.0	17.4	0.93
05:55:00	1790.0	1.93	98.5	17.3	0.92
06:05:00	1800.0	1.94	98.5	17.5	0.94
06:10:00	1805.0	1.95	98.5	17.5	0.94
06:25:00	1820.0	1.97	98.5	17.5	0.94
06:35:00	1830.0	1.98	91.0	17.6	0.95
06:45:00	1840.0	1.99	98.5	17.5	0.94
06:55:00	1850.0	2.00	91.0	17.6	0.95
07:05:00	1860.0	2.01	98.5	17.5	0.94
07:15:00	1870.0	2.02	91.0	17.6	0.95
07:25:00	1880.0	2.03	91.0	17.6	0.95
07:35:00	1890.0	2.04	91.0	17.6	0.95
07:45:00	1900.0	2.05	98.5	17.5	0.94
07:55:00	1910.0	2.06	98.0	17.4	0.93
08:05:00	1920.0	2.07	91.0	17.6	0.95
08:15:00	1930.0	2.08	91.0	17.6	0.95
08:25:00	1940.0	2.10	91.0	17.6	0.95
08:35:00	1950.0	2.11	91.0	17.6	0.95
08:45:00	1960.0	2.12	91.0	17.6	0.95
08:55:00	1970.0	2.13	92.0	17.9	0.96
09:05:00	1980.0	2.14	91.0	17.6	0.95
09:15:00	1990.0	2.15	98.5	17.5	0.94
09:25:00	2000.0	2.16	91.0	17.6	0.95
09:35:00	2010.0	2.17	91.0	17.6	0.95
09:45:00	2020.0	2.18	91.0	17.6	0.95
09:55:00	2030.0	2.19	91.0	17.6	0.95
10:05:00	2040.0	2.20	91.0	17.6	0.95
10:15:00	2050.0	2.21	91.0	17.6	0.95
10:25:00	2060.0	2.22	91.0	17.6	0.95
10:35:00	2070.0	2.24	91.0	17.6	0.95
10:45:00	2080.0	2.25	91.0	17.6	0.95
10:55:00	2090.0	2.26	91.5	17.8	0.95
11:05:00	2100.0	2.27	91.5	17.8	0.95
11:15:00	2110.0	2.28	91.5	17.8	0.95
11:25:00	2120.0	2.29	91.0	17.6	0.95
11:35:00	2130.0	2.30	91.5	17.8	0.95
11:45:00	2140.0	2.31	91.5	17.8	0.95
11:55:00	2150.0	2.32	91.5	17.8	0.95
12:05:00	2160.0	2.33	91.5	17.8	0.95
12:15:00	2170.0	2.34	91.5	17.8	0.95
12:25:00	2180.0	2.35	92.0	17.9	0.96
12:35:00	2190.0	2.37	92.0	17.9	0.96
12:45:00	2200.0	2.38	92.0	17.9	0.96
12:55:00	2210.0	2.39	91.5	17.8	0.95
13:05:00	2220.0	2.40	92.0	17.9	0.96
13:15:00	2230.0	2.41	92.0	17.9	0.96
13:25:00	2240.0	2.42	92.0	17.9	0.96
13:36:00	2251.0	2.43	92.0	17.9	0.96
13:45:00	2260.0	2.44	92.0	17.9	0.96
13:55:00	2270.0	2.45	92.0	17.9	0.96
14:05:00	2280.0	2.46	92.0	17.9	0.96
14:15:00	2290.0	2.47	92.5	18.0	0.97
14:32:00	2307.0	2.49	92.0	17.9	0.96
14:39:00	2314.0	2.50	92.0	17.9	0.96
14:46:00	2321.0	2.51	92.0	17.9	0.96
15:00:00	2335.0	2.52	92.5	18.0	0.97

15:10:00	2345.0	2.53	92.0	17.9	0.96
15:25:00	2360.0	2.55	92.5	18.0	0.97
15:35:00	2370.0	2.56	92.5	18.0	0.97
15:47:00	2382.0	2.57	93.0	18.1	0.98
15:58:00	2393.0	2.58	93.0	18.1	0.98
16:12:00	2407.0	2.60	93.0	18.1	0.98
16:25:00	2420.0	2.61	92.0	17.9	0.96
16:35:00	2430.0	2.62	92.5	18.0	0.97
16:45:00	2440.0	2.63	93.0	18.1	0.98
16:55:00	2450.0	2.65	93.0	18.1	0.98
17:05:00	2460.0	2.66	93.0	18.1	0.98
17:15:00	2470.0	2.67	92.5	18.0	0.97
17:25:00	2480.0	2.68	92.5	18.0	0.97
17:35:00	2490.0	2.69	93.0	18.1	0.98
17:45:00	2500.0	2.70	93.0	18.1	0.98
17:55:00	2510.0	2.71	93.0	18.1	0.98
18:05:00	2520.0	2.72	93.0	18.1	0.98
18:15:00	2530.0	2.73	93.0	18.1	0.98
18:25:00	2540.0	2.74	93.5	18.2	0.98
18:35:00	2550.0	2.75	93.5	18.2	0.98
18:45:00	2560.0	2.76	93.5	18.2	0.98
18:55:00	2570.0	2.78	93.0	18.1	0.98
19:05:00	2580.0	2.79	94.0	18.3	0.99
19:15:00	2590.0	2.80	93.0	18.1	0.98
19:25:00	2600.0	2.81	93.5	18.2	0.98
19:35:00	2610.0	2.82	94.0	18.3	0.99
19:45:00	2620.0	2.83	94.0	18.3	0.99
19:55:00	2630.0	2.84	93.5	18.2	0.98
20:05:00	2640.0	2.85	93.5	18.2	0.98
20:15:00	2650.0	2.86	93.5	18.2	0.98
20:25:00	2660.0	2.87	93.0	18.1	0.98
20:35:00	2670.0	2.88	93.5	18.2	0.98
20:45:00	2680.0	2.89	93.5	18.2	0.98
20:55:00	2690.0	2.90	94.0	18.3	0.99
21:05:00	2700.0	2.92	94.0	18.3	0.99
21:15:00	2710.0	2.93	93.5	18.2	0.98
21:25:00	2720.0	2.94	94.0	18.3	0.99
21:35:00	2730.0	2.95	93.0	18.1	0.98
21:45:00	2740.0	2.96	93.5	18.2	0.98
21:55:00	2750.0	2.97	93.0	18.1	0.98
22:05:00	2760.0	2.98	93.5	18.2	0.98
22:15:00	2770.0	2.99	93.5	18.2	0.98
22:25:00	2780.0	3.00	93.0	18.1	0.98
22:35:00	2790.0	3.01	93.5	18.2	0.98
22:45:00	2800.0	3.02	94.0	18.3	0.99
22:55:00	2810.0	3.03	94.0	18.3	0.99
23:05:00	2820.0	3.05	94.0	18.3	0.99
23:15:00	2830.0	3.06	94.5	18.4	1.00
23:25:00	2840.0	3.07	94.5	18.4	1.00
23:35:00	2850.0	3.08	94.5	18.4	1.00
23:45:00	2860.0	3.09	94.0	18.3	0.99
23:55:00	2870.0	3.10	94.5	18.4	1.00
00:05:00	2880.0	3.11	94.5	18.4	1.00
00:15:00	2890.0	3.12	94.5	18.4	1.00
00:25:00	2900.0	3.13	94.5	18.4	1.00
00:35:00	2910.0	3.14	94.5	18.4	1.00
00:45:00	2920.0	3.15	94.5	18.4	1.00
00:55:00	2930.0	3.16	94.5	18.4	1.00
01:05:00	2940.0	3.17	94.5	18.4	1.00
01:15:00	2950.0	3.19	94.5	18.4	1.00
01:25:00	2960.0	3.20	94.5	18.4	1.00
01:35:00	2970.0	3.21	94.5	18.4	1.00
01:45:00	2980.0	3.22	94.5	18.4	1.00
01:55:00	2990.0	3.23	94.5	18.4	1.00
02:05:00	3000.0	3.24	94.5	18.4	1.00
02:15:00	3010.0	3.25	94.5	18.4	1.00
02:25:00	3020.0	3.26	94.5	18.4	1.00
02:35:00	3030.0	3.27	94.5	18.4	1.00
02:45:00	3040.0	3.28	94.5	18.4	1.00
02:55:00	3050.0	3.29	94.5	18.4	1.00
03:05:00	3060.0	3.30	94.5	18.4	1.00
03:15:00	3070.0	3.32	94.5	18.4	1.00
03:25:00	3080.0	3.33	94.5	18.4	1.00
03:35:00	3090.0	3.34	94.5	18.4	1.00
03:45:00	3100.0	3.35	94.5	18.4	1.00
03:55:00	3110.0	3.36	94.5	18.4	1.00
04:25:00	3140.0	3.39	94.5	18.4	1.00

APPENDIX 2: WOLF - RESNICK MODEL

FILTERS AND CLEARWELL (140 ML/d)
WOLF-RESNICK MODEL: C/Co=1-exp(-A*(T-B))

ITERATION	LOSS	PARAMETER VALUES
0	0.6302559D+00	0.1200D+01
1	0.2539767D+00	0.2086D+01
2	0.2079244D+00	0.1827D+01
3	0.2076854D+00	0.1801D+01
4	0.2076588D+00	0.1807D+01
5	0.2076588D+00	0.1807D+01
6	0.2076588D+00	0.1807D+01

DEPENDENT VARIABLE IS C/Co

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE
REGRESSION	27.999	1	27.999
RESIDUAL	0.208	41	0.005
TOTAL	29.008	42	
CORRECTED	4.137	41	

RAW R-SQUARED (1-RESIDUAL/TOTAL) = 0.993
CORRECTED R-SQUARED (1-RESIDUAL/CORRECTED) = 0.950

PARAMETER	ESTIMATE	
A	1.807	(NON LINEAR REGRESSION)
B	0.73	(DETERMIDE GRAPHICALLY)

FILTERS AND CLEARWELL (180 ML/d)
WOLF-RESNICK MODEL: C/Co=1-exp(-A*(T-B))

ITERATION	LOSS	PARAMETER VALUES
0	0.2041478D+00	0.1200D+01
1	0.2041135D+00	0.1191D+01
2	0.2040987D+00	0.1194D+01
3	0.2040987D+00	0.1194D+01

DEPENDENT VARIABLE IS C/Co

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE
REGRESSION	29.776	1	29.776
RESIDUAL	0.204	45	0.005
TOTAL	27.329	46	
CORRECTED	3.266	45	

RAW R-SQUARED (1-RESIDUAL/TOTAL) = 0.993
CORRECTED R-SQUARED (1-RESIDUAL/CORRECTED) = 0.938

PARAMETER	ESTIMATE	
A	1.194	(NON LINEAR REGRESSION)
B	0.62	(DETERMINED GRAPHICALLY)

CLARIFIER NO.2 (180 ML/d)
WOLF-RESNICK MODEL: C/Co=1-exp(-A*(T-B))

ITERATION	LOSS	PARAMETER VALUES
0	0.2672162D-01	0.1600D+01
1	0.2669448D-01	0.1606D+01
2	0.2669416D-01	0.1605D+01
3	0.2669416D-01	0.1605D+01

DEPENDENT VARIABLE IS C/Co

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE
REGRESSION	11.397	1	11.397
RESIDUAL	0.027	34	0.001
TOTAL	11.799	35	
CORRECTED	3.049	34	

RAW R-SQUARED (1-RESIDUAL/TOTAL) = 0.998
CORRECTED R-SQUARED (1-RESIDUAL/CORRECTED) = 0.991

PARAMETER	ESTIMATE	
A	1.605	(NON LINEAR REGRESSION)
B	0.22	(DETERMINED GRAPHICALLY)

RESERVOIR NO.2 (141 ML/d)
WOLF-RESNICK MODEL: C/Co=1-exp(-A*(T-B))

ITERATION	LOSS	PARAMETER VALUES
0	0.2541460D+00	0.1530D+01
1	0.2541207D+00	0.1542D+01
2	0.2540645D+00	0.1537D+01
3	0.2540638D+00	0.1537D+01
4	0.2540638D+00	0.1537D+01

DEPENDENT VARIABLE IS C/Co

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE
REGRESSION	52.801	1	52.801
RESIDUAL	0.254	81	0.003
TOTAL	52.409	82	
CORRECTED	4.466	81	

RAW R-SQUARED (1-RESIDUAL/TOTAL) = 0.995
CORRECTED R-SQUARED (1-RESIDUAL/CORRECTED) = 0.943

PARAMETER	ESTIMATE	
A	1.537	(NON LINEAR REGRESSION)
B	0.04	(DETERMINED GRAPHICALLY)

RESERVOIR NO.2 (167 ML/d)
WOLF-RESNICK MODEL: C/Co=1-exp(-A*(T-B))

ITERATION	LOSS	PARAMETER VALUES
0	0.2472576D+00	0.1580D+01
1	0.2471727D+00	0.1594D+01
2	0.2471364D+00	0.1589D+01
3	0.2471364D+00	0.1589D+01

DEPENDENT VARIABLE IS C/Co

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE
REGRESSION	60.743	1	60.743
RESIDUAL	0.247	87	0.003
TOTAL	59.209	88	
CORRECTED	4.272	87	

RAW R-SQUARED (1-RESIDUAL/TOTAL) = 0.996
CORRECTED R-SQUARED (1-RESIDUAL/CORRECTED) = 0.942

PARAMETER	ESTIMATE	
A	1.589	(NON LINEAR REGRESSION)
B	0.02	(DETERMINED GRAPHICALLY)

RESERVOIR NO.1 (180 ML/d)
WOLF-RESNICK MODEL: C/Co=1-exp(-A*(T-B))

ITERATION	LOSS	PARAMETER VALUES
0	0.7437440D-01	0.1870D+01
1	0.7436906D-01	0.1868D+01
2	0.7436900D-01	0.1868D+01
3	0.7436900D-01	0.1868D+01

DEPENDENT VARIABLE IS C/Co

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE
REGRESSION	42.291	1	42.291
RESIDUAL	0.074	67	0.001
TOTAL	42.030	68	
CORRECTED	4.526	67	

RAW R-SQUARED (1-RESIDUAL/TOTAL) = 0.998
CORRECTED R-SQUARED (1-RESIDUAL/CORRECTED) = 0.984

PARAMETER	ESTIMATE	
A	1.868	(NON LINEAR REGRESSION)
B	0.22	(DETERMINED GRAPHICALLY)

RESERVOIR NO.1 (230 ML/d)
WOLF-RESNICK MODEL: C/Co=1-exp(-A*(T-B))

ITERATION	LOSS	PARAMETER VALUES
0	0.9053236D-01	0.2220D+01
1	0.9052473D-01	0.2224D+01
2	0.9052469D-01	0.2224D+01
3	0.9052469D-01	0.2224D+01

DEPENDENT VARIABLE IS C/Co

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE
REGRESSION	33.572	1	33.572
RESIDUAL	0.091	47	0.002
TOTAL	33.557	48	
CORRECTED	2.693	47	

RAW R-SQUARED (1-RESIDUAL/TOTAL) = 0.997
CORRECTED R-SQUARED (1-RESIDUAL/CORRECTED) = 0.966

PARAMETER	ESTIMATE	
A	2.224	(NON LINEAR REGRESSION)
B	0.16	(DETERMINED GRAPHICALLY)

RESERVOIR NO.3 (179 ML/d)
WOLF-RESNICK MODEL: C/Co=1-exp(-A*(T-B))

ITERATION	LOSS	PARAMETER VALUES
0	0.1457287D+00	0.1680D+01
1	0.1457164D+00	0.1685D+01
2	0.1457131D+00	0.1683D+01
3	0.1457131D+00	0.1683D+01

DEPENDENT VARIABLE IS C/Co

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE
REGRESSION	55.877	1	55.877
RESIDUAL	0.146	81	0.002
TOTAL	56.396	82	
CORRECTED	4.808	81	

RAW R-SQUARED (1-RESIDUAL/TOTAL) = 0.997
CORRECTED R-SQUARED (1-RESIDUAL/CORRECTED) = 0.970

PARAMETER	ESTIMATE	
A	1.683	(NON LINEAR REGRESSION)
B	0.01	(DETERMINED GRAPHICALLY)

RESERVOIR NO.3 (198 ML/d)
WOLF-RESNICK MODEL: C/Co=1-exp(-A*(T-B))

ITERATION	LOSS	PARAMETER VALUES
0	0.2035537D+00	0.1590D+01
1	0.2029091D+00	0.1632D+01
2	0.2025005D+00	0.1616D+01
3	0.2025001D+00	0.1616D+01
4	0.2025001D+00	0.1616D+01

DEPENDENT VARIABLE IS C/Co

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE
REGRESSION	26.949	1	26.949
RESIDUAL	0.203	57	0.004
TOTAL	26.113	58	
CORRECTED	3.294	57	

RAW R-SQUARED (1-RESIDUAL/TOTAL) = 0.992
CORRECTED R-SQUARED (1-RESIDUAL/CORRECTED) = 0.939

PARAMETER	ESTIMATE	
A	1.616	(NON LINEAR REGRESSION)
B	0.01	(DETERMINED GRAPHICALLY)

RESERVOIRS NOS. 1,2,3 (170 ML/d)
WOLF-RESNICK MODEL: C/Co=1-exp(-A*(T-B))

ITERATION	LOSS	PARAMETER VALUES
0	0.7016456D-01	0.1600D+01
1	0.7008512D-01	0.1596D+01
2	0.7008490D-01	0.1596D+01
3	0.7008490D-01	0.1596D+01

DEPENDENT VARIABLE IS C/Co

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE
REGRESSION	212.603	1	212.603
RESIDUAL	0.070	298	0.000
TOTAL	210.994	299	
CORRECTED	17.934	298	

RAW R-SQUARED (1-RESIDUAL/TOTAL) = 1.000
CORRECTED R-SQUARED (1-RESIDUAL/CORRECTED) = 0.996

PARAMETER	ESTIMATE	
A	1.596	(NON LINEAR REGRESSION)
B	0.11	(DETERMINED GRAPHICALLY)

APPENDIX 3: REBHUN - ARGAMAN MODEL

FILTERS+CLEARWELL (140 ML/d) - REBHUN-ARGAMAN MODEL

REAL C/Co	(To-Ti)/Td	log(1-C/Co)	CORRECTION (To-Ti)/Td	log(C/Co)
0.00	0.00	0.00	-0.73	0.62
0.00	0.19	0.00	-0.54	0.46
0.00	0.24	0.00	-0.49	0.42
0.00	0.30	0.00	-0.43	0.37
0.00	0.35	0.00	-0.38	0.32
0.00	0.41	0.00	-0.32	0.28
0.00	0.46	0.00	-0.27	0.23
0.00	0.51	0.00	-0.22	0.18
0.00	0.57	0.00	-0.16	0.14
0.00	0.62	0.00	-0.11	0.09
0.00	0.68	0.00	-0.05	0.05
0.02	0.73	-0.01	0.00	0.00
0.04	0.78	-0.02	0.05	-0.05
0.14	0.84	-0.07	0.11	-0.09
0.14	0.89	-0.07	0.16	-0.14
0.18	0.95	-0.08	0.22	-0.18
0.27	1.00	-0.14	0.27	-0.23
0.33	1.05	-0.18	0.32	-0.28
0.46	1.11	-0.27	0.38	-0.32
0.56	1.16	-0.35	0.43	-0.37
0.58	1.22	-0.38	0.49	-0.42
0.66	1.27	-0.47	0.54	-0.46
0.69	1.32	-0.50	0.59	-0.51
0.56	1.38	-0.35	0.65	-0.55
0.74	1.43	-0.58	0.70	-0.60
0.83	1.49	-0.78	0.76	-0.65
0.76	1.54	-0.61	0.81	-0.69
0.90	1.59	-1.02	0.86	-0.74
0.87	1.65	-0.88	0.92	-0.78
0.95	1.70	-1.27	0.97	-0.83
0.94	1.76	-1.21	1.03	-0.88
0.95	1.89	-1.27	1.16	-0.99
0.87	2.03	-0.88	1.30	-1.11
0.85	2.16	-0.83	1.43	-1.22
1.01	2.30	-3.00	1.57	-1.34
0.96	2.43	-1.44	1.70	-1.45
1.02	2.57	-3.00	1.84	-1.57
1.02	2.70	-3.00	1.97	-1.68
1.02	2.84	-3.00	2.11	-1.80
0.98	2.97	-1.73	2.24	-1.91
0.91	3.16	-1.06	2.43	-2.08
0.98	3.24	-1.73	2.51	-2.15
0.95	3.38	-1.27	2.65	-2.26
0.96	3.65	-1.44	2.92	-2.49
0.97	3.78	-1.56	3.05	-2.61
1.07	3.92	-3.00	3.19	-2.72
1.08	4.05	-3.00	3.32	-2.84
1.08	4.15	-3.00	3.42	-2.92
1.09	4.32	-3.00	3.59	-3.07
0.89	4.46	-0.94	3.73	-3.18
1.00	4.59	-2.87	3.86	-3.30
1.00	4.86	-2.87	4.14	-3.53
1.04	4.97	-3.00	4.24	-3.62

CALCULATION

Regression: About 90% of the Data (Log 0.1=-1)
The Non-Zero C/Co Started at 0.03
Intercept=loge p/(1-p 0.6228 >>>>> p= 58.9%
slope=(-)loge /(1-d)(1-p)= -0.8536 >>>>> d= -23.8%

Regression Statistics

Multiple R	0.93
R Square	0.86
Adjusted R Squar	0.80
Standard Error	0.11
Observations	17.00

Analysis of Variance

	df	um of Square	Mean Square	F	Ignificance F
Regression	1.00	1.15	1.15	101.46	4.54E-08
Residual	16.00	0.18	0.01		
Total	17.00	1.33			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
x1	-0.85	0.05	-16.76	0.00	-0.96158	-0.74569

FILTERS+CLEARWELL (180 ML/d) - REBHUN-ARGAMAN MODEL

REAL C/Co	(To-Ti)/Td	log(1-C/Co)	CORRECTION (To-Ti)/Td	log(C/Co)
0.01	0.00	0.00	-0.62	0.30
0.01	0.07	0.00	-0.55	0.27
0.00	0.14	0.00	-0.48	0.24
0.00	0.21	0.00	-0.41	0.20
-0.01	0.28	0.00	-0.34	0.17
-0.01	0.34	0.00	-0.28	0.14
-0.01	0.41	0.00	-0.21	0.10
0.00	0.48	0.00	-0.14	0.07
0.00	0.55	0.00	-0.07	0.03
0.01	0.62	-0.01	0.00	0.00
0.05	0.69	-0.02	0.07	-0.03
0.11	0.76	-0.05	0.14	-0.07
0.17	0.83	-0.08	0.21	-0.10
0.19	0.90	-0.09	0.28	-0.14
0.29	0.97	-0.15	0.34	-0.17
0.39	1.03	-0.21	0.41	-0.20
0.48	1.10	-0.28	0.48	-0.24
0.46	1.17	-0.27	0.55	-0.27
0.59	1.24	-0.36	0.62	-0.30
0.61	1.31	-0.41	0.69	-0.34
0.67	1.38	-0.48	0.76	-0.37
0.59	1.45	-0.39	0.83	-0.41
0.74	1.52	-0.58	0.90	-0.44
0.79	1.59	-0.68	0.97	-0.47
0.67	1.66	-0.49	1.03	-0.51
0.74	1.72	-0.59	1.10	-0.54
0.82	1.79	-0.74	1.17	-0.58
0.82	1.86	-0.74	1.24	-0.61
0.79	1.93	-0.68	1.31	-0.64
0.81	2.00	-0.73	1.38	-0.68
0.81	2.07	-0.73	1.45	-0.71
0.87	2.24	-0.90	1.62	-0.80
0.88	2.41	-0.92	1.79	-0.88
0.83	2.59	-0.76	1.97	-0.97
0.89	2.76	-0.98	2.14	-1.05
0.85	2.93	-0.83	2.31	-1.13
0.93	3.10	-1.15	2.48	-1.22
0.93	3.28	-1.15	2.66	-1.30
0.93	3.45	-1.15	2.83	-1.39
0.87	3.62	-0.90	3.00	-1.47
0.87	3.79	-0.90	3.17	-1.56
0.90	3.97	-1.01	3.34	-1.64
0.92	4.14	-1.07	3.52	-1.73
0.85	4.31	-0.83	3.69	-1.81
0.92	4.48	-1.07	3.86	-1.90
0.95	4.66	-1.30	4.03	-1.98
0.96	4.83	-1.36	4.21	-2.07
0.96	5.00	-1.36	4.38	-2.15
0.92	5.17	-1.07	4.55	-2.24
0.98	5.34	-1.79	4.72	-2.32
0.90	5.52	-1.01	4.90	-2.41
0.94	5.69	-1.19	5.07	-2.49
0.90	5.86	-1.01	5.24	-2.57
0.87	6.03	-0.88	5.41	-2.66
0.85	6.21	-0.81	5.59	-2.74

CALCULATION

Regression: About 90% of the Data (Log 0.1=-1)
The Non-Zero C/Co Started at 0.03
Intercept=loge p/(1-p 0.3049 >>>>> p= 41.2%
slope=(-)loge /(1-d)(1-p)= -0.4913 >>>>> d= -50.5%

Regression Statistics

Multiple R	0.94
R Square	0.88
Adjusted R Squar	0.84
Standard Error	0.11
Observations	27.00

Analysis of Variance

	df	Sum of Square	Mean Square	F	Ignificance F
Regression	1.00	2.11	2.11	186.82	0.00
Residual	26.00	0.29	0.01		
Total	27.00	2.40			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
x1	-0.49	0.02	-27.51	0.00	-0.53	-0.45

CLARIFIER NO.2 (180 ML/d) - REBHUN-ARGAMAN MODEL

REAL C/Co	(To-Ti)/Td	log(1-C/Co)	CORRECTION (To-Ti)/Td	log(C/Co)
0.00	0.01	0.00	-0.22	0.16
0.00	0.03	0.00	-0.19	0.14
0.00	0.06	0.00	-0.16	0.12
0.01	0.08	0.00	-0.14	0.10
0.01	0.10	0.00	-0.12	0.08
0.00	0.13	0.00	-0.09	0.07
0.00	0.15	0.00	-0.07	0.05
0.00	0.17	0.00	-0.05	0.03
0.00	0.20	0.00	-0.02	0.02
0.02	0.22	-0.01	0.00	0.00
0.07	0.24	-0.03	0.02	-0.02
0.08	0.27	-0.03	0.05	-0.03
0.09	0.29	-0.04	0.07	-0.05
0.13	0.31	-0.06	0.09	-0.07
0.13	0.34	-0.06	0.12	-0.08
0.18	0.36	-0.08	0.14	-0.10
0.20	0.38	-0.10	0.16	-0.12
0.27	0.41	-0.14	0.19	-0.14
0.27	0.43	-0.14	0.21	-0.15
0.30	0.45	-0.15	0.23	-0.17
0.31	0.48	-0.16	0.26	-0.19
0.34	0.50	-0.18	0.28	-0.20
0.37	0.55	-0.20	0.33	-0.24
0.42	0.57	-0.23	0.35	-0.25
0.43	0.59	-0.24	0.37	-0.27
0.45	0.62	-0.26	0.40	-0.29
0.48	0.64	-0.29	0.42	-0.30
0.49	0.66	-0.30	0.44	-0.32
0.51	0.69	-0.31	0.47	-0.34
0.55	0.74	-0.35	0.52	-0.38
0.62	0.80	-0.41	0.58	-0.42
0.63	0.86	-0.43	0.64	-0.46
0.68	0.93	-0.50	0.71	-0.52
0.71	0.98	-0.54	0.76	-0.55
0.77	1.05	-0.64	0.83	-0.60
0.77	1.10	-0.64	0.88	-0.64
0.80	1.19	-0.70	0.97	-0.70
0.82	1.24	-0.75	1.02	-0.74
0.86	1.30	-0.85	1.08	-0.79
0.87	1.36	-0.88	1.14	-0.83
0.92	1.53	-1.11	1.31	-0.95
0.95	1.71	-1.26	1.49	-1.08
1.00	1.88	-3.00	1.66	-1.21
1.00	2.07	-3.00	1.85	-1.34

CALCULATION

Regression: About 90% of the Data (Log 0.1=-1)
The Non-Zero C/Co Started at 0.03
Intercept=loge p/(1-p 0.1562 >>>>> p= 26.5%
slope=(-)loge /(1-d)(1-p)= -0.7263 >>>>> d= 18.7%

Regression Statistics

Multiple R	1.00
R Square	0.99
Adjusted R Squar	0.96
Standard Error	0.03
Observations	31.00

Analysis of Variance

	df	Sum of Squares	Mean Square	F	Ignificance F
Regression	1.00	1.96	1.96	3066.87	0.00
Residual	30.00	0.02	0.00		
Total	31.00	1.98			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
x1	-0.73	0.01	-88.52	0.00	-0.74	-0.71

RESERVOIR NO.2 (141 ML/d) - REBHUN-ARGAMAN MODEL

REAL DATA C/Co	(Te-Ti)/Td	log(1-C/Co)	CORRECTION (Te-Ti)/Td	log(1-C/Co)
0.00	0.00	0.00	-0.04	0.02
0.00	0.00	0.00	-0.04	0.02
0.00	0.00	0.00	-0.04	0.02
0.00	0.00	0.00	-0.04	0.02
0.00	0.04	0.00	0.00	0.00
0.17	0.06	-0.09	0.03	-0.01
0.27	0.09	-0.14	0.06	-0.03
0.27	0.12	-0.14	0.09	-0.06
0.29	0.16	-0.15	0.12	-0.07
0.30	0.19	-0.16	0.15	-0.09
0.33	0.22	-0.18	0.18	-0.11
0.44	0.25	-0.26	0.21	-0.12
0.43	0.29	-0.24	0.25	-0.14
0.44	0.32	-0.25	0.28	-0.16
0.45	0.35	-0.26	0.31	-0.18
0.47	0.39	-0.27	0.35	-0.20
0.51	0.42	-0.31	0.38	-0.22
0.52	0.45	-0.32	0.42	-0.24
0.51	0.49	-0.34	0.45	-0.26
0.56	0.53	-0.36	0.49	-0.29
0.58	0.56	-0.38	0.52	-0.30
0.60	0.59	-0.39	0.55	-0.32
0.60	0.62	-0.40	0.58	-0.34
0.61	0.66	-0.41	0.62	-0.36
0.63	0.69	-0.43	0.65	-0.38
0.63	0.72	-0.43	0.69	-0.39
0.65	0.76	-0.46	0.72	-0.41
0.65	0.79	-0.46	0.75	-0.43
0.67	0.82	-0.48	0.79	-0.45
0.67	0.86	-0.49	0.82	-0.47
0.71	0.89	-0.53	0.86	-0.49
0.74	0.92	-0.58	0.94	-0.54
0.74	0.99	-0.58	0.95	-0.55
0.75	1.03	-0.60	0.99	-0.57
0.76	1.06	-0.62	1.02	-0.59
0.76	1.09	-0.62	1.06	-0.61
0.78	1.14	-0.65	1.10	-0.63
0.79	1.16	-0.67	1.12	-0.65
0.79	1.19	-0.69	1.16	-0.67
0.79	1.23	-0.69	1.19	-0.68
0.79	1.26	-0.69	1.22	-0.70
0.80	1.29	-0.70	1.26	-0.72
0.82	1.33	-0.74	1.29	-0.74
0.82	1.36	-0.74	1.32	-0.76
0.83	1.39	-0.78	1.36	-0.78
0.82	1.43	-0.74	1.39	-0.80
0.83	1.46	-0.78	1.42	-0.82
0.83	1.50	-0.76	1.46	-0.84
0.86	1.54	-0.86	1.50	-0.87
0.87	1.56	-0.90	1.52	-0.88
0.87	1.60	-0.87	1.56	-0.90
0.83	1.63	-0.78	1.60	-0.92
0.84	1.67	-0.80	1.63	-0.94
0.87	1.70	-0.87	1.66	-0.96
0.91	1.73	-1.06	1.69	-0.97
0.92	1.76	-1.10	1.72	-0.99
0.91	1.80	-1.06	1.76	-1.01
0.94	1.82	-1.20	1.79	-1.03
0.94	1.86	-1.26	1.82	-1.06
0.93	1.89	-1.15	1.86	-1.07
0.94	1.93	-1.26	1.89	-1.09
0.96	1.96	-1.40	1.92	-1.10
0.97	1.99	-1.50	1.95	-1.12
0.94	2.03	-1.26	1.99	-1.15
0.93	2.07	-1.15	2.03	-1.17
0.96	2.08	-1.62	2.04	-1.18
1.00	2.11	-3.00	2.07	-1.20
0.96	2.15	-1.80	2.11	-1.22
0.96	2.20	-1.62	2.16	-1.24
0.99	2.22	-2.10	2.18	-1.26
1.01	2.25	-3.00	2.21	-1.27
0.96	2.30	-1.80	2.26	-1.30
1.01	2.32	-3.00	2.29	-1.31
0.99	2.36	-2.10	2.32	-1.34
0.97	2.40	-1.80	2.36	-1.36
0.97	2.43	-1.80	2.39	-1.38
0.96	2.46	-1.62	2.42	-1.40
1.00	2.49	-3.00	2.46	-1.41
0.99	2.54	-2.10	2.50	-1.44
1.00	2.56	-3.00	2.52	-1.45
1.00	2.59	-3.00	2.56	-1.47
1.00	2.63	-3.00	2.59	-1.49
1.00	2.66	-3.00	2.62	-1.51
1.00	2.70	-3.00	2.66	-1.53
1.00	2.73	-3.00	2.69	-1.55
1.00	2.75	-3.00	2.71	-1.56

CALCULATION

Regression About 90% of the Data (Log 0.1=-1)
The Non-Zero C/Co Start at 0.03
Intercept=loge p/(1- 0.0202 >>>>> p 4.45%
slope=(-)loge /(1-m)x(1-p)= -0.5768 >>>>> m 21.18%

Regression Statistics

Multiple R	0.97
R Square	0.93
Adjusted R Squar	0.91
Standard Error	0.07
Observations	61.00

Analysis of Variance

	df	Sum of Square	Mean Square	F	gnificance F
Regression	1.00	2.96	2.96	682.13	0.00
Residual	60.00	0.22	0.00		
Total	61.00	3.17			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
x1	-0.58	0.01	-41.21	0.00	-0.60	-0.56

RESERVOIR NO.2 (167 ML/d) - REBHUN-ARGAMAN MODEL

REAL DATA			CORRECTION	
C/Co	(To-Ti)/Td	log(1-C/Co)	(To-Ti)/Td	log(1-C/Co)
0.00	0.00	0.00	-0.02	0.01
0.00	0.00	0.00	-0.02	0.01
0.00	0.00	0.00	-0.02	0.01
0.00	0.02	0.00	0.00	0.00
0.17	0.04	-0.08	0.02	-0.01
0.22	0.08	-0.11	0.06	-0.03
0.31	0.11	-0.16	0.09	-0.05
0.33	0.14	-0.18	0.13	-0.08
0.34	0.18	-0.18	0.16	-0.10
0.41	0.21	-0.23	0.20	-0.12
0.46	0.25	-0.27	0.23	-0.14
0.47	0.29	-0.28	0.27	-0.16
0.45	0.32	-0.26	0.30	-0.18
0.49	0.36	-0.29	0.34	-0.20
0.50	0.39	-0.30	0.38	-0.22
0.54	0.43	-0.34	0.41	-0.25
0.51	0.47	-0.31	0.45	-0.27
0.55	0.50	-0.35	0.48	-0.29
0.60	0.54	-0.40	0.52	-0.31
0.60	0.59	-0.40	0.57	-0.34
0.61	0.61	-0.41	0.59	-0.35
0.63	0.64	-0.43	0.63	-0.37
0.66	0.68	-0.47	0.66	-0.40
0.71	0.71	-0.54	0.70	-0.42
0.69	0.75	-0.51	0.73	-0.44
0.69	0.79	-0.51	0.77	-0.46
0.69	0.82	-0.51	0.80	-0.48
0.69	0.86	-0.51	0.84	-0.50
0.69	0.90	-0.51	0.88	-0.52
0.73	0.93	-0.57	0.91	-0.55
0.74	0.97	-0.58	0.95	-0.57
0.77	1.00	-0.64	0.98	-0.59
0.77	1.04	-0.64	1.02	-0.61
0.78	1.07	-0.66	1.05	-0.63
0.80	1.11	-0.69	1.09	-0.65
0.83	1.14	-0.77	1.12	-0.67
0.83	1.18	-0.77	1.17	-0.70
0.84	1.22	-0.80	1.21	-0.72
0.84	1.25	-0.80	1.23	-0.74
0.81	1.29	-0.73	1.27	-0.76
0.83	1.32	-0.77	1.30	-0.78
0.83	1.35	-0.77	1.34	-0.80
0.84	1.39	-0.80	1.37	-0.82
0.84	1.43	-0.80	1.41	-0.84
0.84	1.46	-0.80	1.44	-0.86
0.87	1.49	-0.87	1.48	-0.88
0.87	1.53	-0.87	1.51	-0.90
0.87	1.57	-0.87	1.55	-0.93
0.89	1.60	-0.96	1.59	-0.95
0.90	1.64	-1.00	1.62	-0.97
0.92	1.67	-1.08	1.65	-0.99
0.88	1.71	-0.93	1.69	-1.01
0.88	1.75	-0.93	1.74	-1.04
0.90	1.78	-1.00	1.76	-1.05
0.91	1.81	-1.04	1.79	-1.07
0.90	1.86	-1.00	1.84	-1.10
0.90	1.89	-1.00	1.87	-1.12
0.91	1.92	-1.04	1.90	-1.14
0.93	1.95	-1.18	1.93	-1.16
0.91	1.99	-1.16	1.97	-1.18
0.94	2.02	-1.24	2.00	-1.20
0.96	2.06	-1.40	2.04	-1.22
0.95	2.09	-1.31	2.07	-1.24
0.97	2.12	-1.50	2.10	-1.26
0.95	2.16	-1.31	2.15	-1.28
0.95	2.20	-1.31	2.18	-1.30
0.93	2.25	-1.13	2.24	-1.34
0.95	2.27	-1.31	2.25	-1.35
0.95	2.31	-1.31	2.29	-1.37
0.97	2.34	-1.50	2.32	-1.39
0.99	2.36	-1.85	2.34	-1.40
0.99	2.40	-1.85	2.38	-1.42
0.99	2.43	-2.24	2.41	-1.44
0.99	2.47	-2.24	2.45	-1.46
0.99	2.51	-1.85	2.49	-1.49
0.99	2.54	-1.85	2.53	-1.51
0.99	2.58	-2.24	2.56	-1.53
0.97	2.63	-1.50	2.61	-1.56
0.96	2.67	-1.40	2.65	-1.58
0.98	2.70	-1.40	2.68	-1.61
0.96	2.74	-1.40	2.72	-1.63
0.95	2.78	-1.31	2.76	-1.65
0.97	2.81	-1.50	2.79	-1.67
0.97	2.84	-1.50	2.83	-1.69
0.99	2.87	-1.85	2.85	-1.71
0.99	2.90	-2.24	2.88	-1.72
0.99	2.94	-2.24	2.92	-1.75
0.99	2.98	-1.85	2.96	-1.77
0.99	3.01	-2.24	2.99	-1.79
1.00	3.04	-3.00	3.03	-1.81
1.00	3.08	-3.00	3.06	-1.83

CALCULATION

Regression About 90% of the Data (Log 0.1=-1)
The Non-Zero C/Co Start at 0.03
Intercept=log p/(1-p) 0.0108 >>>>> p= 2.43%
slope=(-)log a/(1-d)(1-p)= -0.5879 >>>>> d= 25.55%

Regression Statistics

Multiple R	0.97
R Square	0.94
Adjusted R Square	0.92
Standard Error	0.07
Observations	55.00

Analysis of variance

	df	um of Square	Mean Square	F	ignificance F
Regression	1.00	4.39	4.39	857.30	0.00
Residual	54.00	0.28	0.01		
Total	55.00	4.67			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
x1	-0.60	0.01	-68.25	0.00	-0.62	-0.58

RESERVOIR NO.1 (190 ML/d) - REBHUN-ARGAMAN MODEL

REAL C/Co	(To-T)/Td	log(1-C/Co)	CORRECTION (To-T)/Td	log(C/Co)
0.00	0.00	0.00	-0.22	0.16
0.00	0.00	0.00	-0.22	0.16
0.00	0.02	0.00	-0.20	0.15
0.00	0.06	0.00	-0.17	0.12
0.00	0.09	0.00	-0.13	0.10
0.00	0.12	0.00	-0.10	0.07
0.02	0.14	-0.01	-0.08	0.06
0.00	0.15	0.00	-0.07	0.06
0.01	0.17	0.00	-0.06	0.04
0.02	0.19	-0.01	-0.03	0.02
0.02	0.22	-0.01	0.00	0.00
0.07	0.25	-0.03	0.03	-0.02
0.11	0.27	-0.06	0.05	-0.03
0.13	0.29	-0.07	0.08	-0.06
0.23	0.31	-0.11	0.09	-0.07
0.27	0.36	-0.14	0.12	-0.09
0.33	0.38	-0.18	0.16	-0.12
0.34	0.41	-0.18	0.19	-0.14
0.39	0.44	-0.21	0.22	-0.16
0.47	0.47	-0.27	0.25	-0.19
0.45	0.51	-0.26	0.29	-0.21
0.49	0.54	-0.30	0.32	-0.24
0.50	0.57	-0.30	0.35	-0.26
0.56	0.61	-0.36	0.38	-0.29
0.59	0.66	-0.39	0.43	-0.32
0.58	0.67	-0.38	0.45	-0.33
0.59	0.71	-0.39	0.48	-0.36
0.60	0.74	-0.40	0.52	-0.38
0.62	0.77	-0.43	0.55	-0.41
0.63	0.80	-0.44	0.58	-0.43
0.65	0.84	-0.48	0.61	-0.46
0.66	0.87	-0.47	0.65	-0.48
0.72	0.89	-0.56	0.67	-0.50
0.72	0.92	-0.56	0.70	-0.52
0.74	0.96	-0.59	0.73	-0.54
0.76	0.99	-0.61	0.76	-0.57
0.78	1.02	-0.66	0.80	-0.59
0.79	1.05	-0.68	0.83	-0.62
0.80	1.08	-0.69	0.86	-0.64
0.76	1.12	-0.61	0.90	-0.67
0.78	1.15	-0.66	0.93	-0.69
0.81	1.18	-0.71	0.96	-0.71
0.81	1.22	-0.73	1.00	-0.74
0.85	1.25	-0.81	1.03	-0.76
0.86	1.28	-0.84	1.06	-0.79
0.87	1.31	-0.89	1.09	-0.81
0.86	1.36	-0.84	1.14	-0.85
0.87	1.38	-0.89	1.16	-0.86
0.88	1.41	-0.92	1.19	-0.88
0.88	1.48	-0.92	1.26	-0.93
0.89	1.51	-0.95	1.29	-0.96
0.87	1.56	-0.89	1.33	-0.99
0.87	1.58	-0.89	1.36	-1.01
0.89	1.61	-0.96	1.39	-1.03
0.89	1.64	-0.95	1.42	-1.05
0.91	1.67	-1.06	1.45	-1.08
0.90	1.71	-1.02	1.49	-1.10
0.93	1.74	-1.15	1.52	-1.12
0.94	1.77	-1.20	1.56	-1.15
0.93	1.80	-1.26	1.58	-1.17
0.93	1.84	-1.15	1.62	-1.20
0.95	1.86	-1.33	1.64	-1.22
0.95	1.80	-1.33	1.68	-1.24
0.93	1.83	-1.33	1.71	-1.27
0.93	1.96	-1.33	1.74	-1.29
0.91	2.00	-1.33	1.78	-1.32
0.93	2.03	-1.33	1.81	-1.34
0.98	2.03	-1.67	1.81	-1.34
0.96	2.07	-1.67	1.84	-1.37
1.04	2.07	-3.00	1.85	-1.37
1.01	2.10	-3.00	1.88	-1.40
1.01	2.14	-3.00	1.92	-1.42
1.01	2.17	-3.00	1.95	-1.45
0.99	2.21	-2.29	1.98	-1.48
0.99	2.25	-2.29	2.02	-1.50
0.98	2.30	-1.67	2.08	-1.54
1.00	2.31	-3.00	2.09	-1.55
0.99	2.36	-2.29	2.13	-1.58

CALCULATION

Regression: About 90% of the Data (Log 0.1>-1)

The Non-Zero C/Co Started at: 0.03

intercept=loge p/(1- 0.1838 >>>>> p= 27.4%

slope=(-)loge A(1-d)(1-p)= -0.7411 >>>>> d= 19.3%

Regression Statistics

Multiple R	0.99
R Square	0.97
Adjusted R Squar	0.96
Standard Error	0.06
Observations	47.00

Analysis of Variance

	df	Sum of Square	Mean Square	F	gnificance F
Regression	1.00	4.21	4.21	1519.60	0.00
Residual	46.00	0.13	0.00		
Total	47.00	4.33			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
x1	-0.74	0.01	-81.19	0.00	-0.76	-0.72

RESERVOIR NO.3 (179 ML/d) - REBHUN-ARGAMAN MODEL

REAL DATA C/Co	(To-T)/Td	log(1-C/Co)	CORRECTION (To-T)/Td	log(1-C/Co)
0.00	0.00	0.00	-0.01	0.01
0.00	0.00	0.00	-0.01	0.01
0.00	0.01	0.00	0.00	0.00
0.10	0.04	-0.05	0.03	-0.02
0.25	0.07	-0.12	0.06	-0.04
0.26	0.11	-0.13	0.09	-0.06
0.26	0.15	-0.13	0.13	-0.09
0.32	0.18	-0.17	0.16	-0.11
0.36	0.21	-0.19	0.20	-0.13
0.43	0.25	-0.24	0.23	-0.16
0.43	0.28	-0.24	0.27	-0.18
0.47	0.32	-0.27	0.30	-0.20
0.50	0.36	-0.30	0.34	-0.23
0.53	0.38	-0.33	0.37	-0.25
0.53	0.42	-0.33	0.41	-0.27
0.52	0.46	-0.32	0.44	-0.29
0.56	0.49	-0.38	0.48	-0.32
0.57	0.53	-0.37	0.51	-0.34
0.59	0.56	-0.39	0.54	-0.36
0.61	0.59	-0.41	0.58	-0.39
0.64	0.63	-0.44	0.61	-0.41
0.67	0.66	-0.49	0.65	-0.43
0.69	0.70	-0.51	0.68	-0.45
0.68	0.73	-0.50	0.72	-0.48
0.76	0.77	-0.53	0.75	-0.50
0.72	0.80	-0.55	0.79	-0.53
0.73	0.85	-0.57	0.84	-0.56
0.74	0.87	-0.58	0.86	-0.57
0.78	0.91	-0.65	0.89	-0.59
0.76	0.94	-0.61	0.93	-0.62
0.76	0.98	-0.61	0.96	-0.64
0.76	1.01	-0.61	1.00	-0.66
0.77	1.05	-0.63	1.03	-0.69
0.78	1.08	-0.67	1.07	-0.71
0.82	1.12	-0.75	1.10	-0.73
0.79	1.15	-0.68	1.14	-0.76
0.78	1.19	-0.67	1.18	-0.78
0.79	1.22	-0.68	1.21	-0.80
0.86	1.25	-0.85	1.24	-0.82
0.87	1.29	-0.87	1.27	-0.85
0.88	1.32	-0.94	1.31	-0.87
0.88	1.36	-0.94	1.34	-0.89
0.90	1.39	-1.01	1.38	-0.92
0.88	1.43	-0.94	1.42	-0.94
0.89	1.46	-0.97	1.45	-0.96
0.88	1.50	-0.90	1.48	-0.99
0.88	1.53	-0.94	1.52	-1.01
0.92	1.56	-1.10	1.55	-1.03
0.90	1.60	-1.01	1.59	-1.06
0.90	1.64	-1.01	1.62	-1.08
0.91	1.67	-1.06	1.65	-1.10
0.91	1.70	-1.06	1.69	-1.12
0.96	1.72	-1.37	1.71	-1.14
0.97	1.75	-1.48	1.74	-1.16
0.97	1.79	-1.48	1.77	-1.18
0.97	1.82	-1.48	1.81	-1.20
0.98	1.85	-1.61	1.84	-1.22
0.98	1.88	-1.61	1.87	-1.24
0.98	1.91	-1.82	1.90	-1.26
1.01	1.93	-3.00	1.92	-1.28
0.99	1.97	-2.22	1.96	-1.30
0.99	2.01	-2.22	1.99	-1.33
1.00	2.04	-3.00	2.02	-1.35
1.01	2.07	-3.00	2.06	-1.37
1.01	2.11	-3.00	2.10	-1.39
0.98	2.16	-1.82	2.14	-1.43
0.98	2.20	-1.61	2.19	-1.45
0.98	2.34	-1.61	2.22	-1.48
0.99	2.26	-2.22	2.24	-1.49
0.99	2.29	-2.22	2.28	-1.51
0.98	2.34	-1.82	2.32	-1.54
1.00	2.36	-3.00	2.34	-1.56
1.00	2.39	-3.00	2.38	-1.58
1.02	2.43	-3.00	2.41	-1.61
1.02	2.46	-3.00	2.45	-1.63
1.02	2.50	-3.00	2.48	-1.65
1.03	2.53	-3.00	2.52	-1.68
1.03	2.57	-3.00	2.55	-1.70
1.04	2.60	-3.00	2.59	-1.72
1.03	2.64	-3.00	2.63	-1.75
1.02	2.67	-3.00	2.66	-1.77
0.98	2.73	-1.61	2.72	-1.81
1.01	2.75	-3.00	2.73	-1.82
1.01	2.78	-3.00	2.77	-1.84

CALCULATION

Regression: About 90% of the Data (Log 0.1=-1)
The Non-Zero C/Co Start at 0.03
Intercept=loge p/(1-p 0.0094 >>>>> p= 2.12%
slope=(-)loge β(1-α)/(1-p)= -0.6650 >>>>> m 33.28%

Regression Statistics

Multiple R	0.99
R Square	0.95
Adjusted R Squar	0.94
Standard Error	0.06
Observations	49.00

Analysis of Variance

	df	Sum of Square	Mean Square	F	Significance F
Regression	1.00	4.00	4.00	1221.79	0.00
Residual	47.00	0.15	0.00		
Total	48.00	4.15			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
x1	-0.67	0.01	-79.97	0.00	-0.68	-0.66

RESERVOIR NO. 1 (230 ML/d) - REBHUN-ARGAMAN MODEL

REAL DATA C/Co	(To-T)/Td	log(1-C/Co)	CORRECTION (To-T)/Td	log(1-C/Co)
0.00	0.00	0.00	-0.16	0.16
0.00	0.00	0.00	-0.16	0.16
0.01	0.03	0.00	-0.14	0.13
0.00	0.07	0.00	-0.09	0.09
0.00	0.12	0.00	-0.05	0.04
0.00	0.16	0.00	0.00	0.00
0.10	0.30	-0.09	0.04	-0.03
0.40	0.34	-0.22	0.08	-0.07
0.37	0.31	-0.20	0.13	-0.13
0.41	0.38	-0.23	0.21	-0.20
0.46	0.42	-0.27	0.26	-0.24
0.51	0.47	-0.31	0.30	-0.29
0.53	0.51	-0.33	0.35	-0.32
0.61	0.55	-0.41	0.39	-0.36
0.63	0.60	-0.44	0.44	-0.40
0.64	0.65	-0.44	0.48	-0.45
0.66	0.69	-0.46	0.53	-0.49
0.68	0.74	-0.49	0.57	-0.53
0.72	0.78	-0.56	0.62	-0.57
0.75	0.82	-0.60	0.66	-0.61
0.76	0.87	-0.63	0.70	-0.65
0.78	0.91	-0.66	0.75	-0.69
0.84	0.95	-0.80	0.79	-0.73
0.85	1.00	-0.82	0.88	-0.82
0.85	1.09	-0.82	0.93	-0.86
0.86	1.13	-0.86	0.97	-0.90
0.89	1.17	-0.95	1.01	-0.93
0.90	1.22	-1.02	1.05	-0.97
0.90	1.26	-0.96	1.10	-1.02
0.93	1.31	-1.14	1.14	-1.06
0.95	1.35	-1.30	1.19	-1.10
0.95	1.40	-1.30	1.23	-1.14
0.93	1.44	-1.19	1.28	-1.18
0.95	1.49	-1.30	1.32	-1.22
0.90	1.53	-1.02	1.37	-1.27
0.93	1.58	-1.19	1.41	-1.31
0.95	1.62	-1.30	1.46	-1.35
0.95	1.67	-1.30	1.50	-1.39
0.96	1.71	-1.39	1.55	-1.43
0.97	1.75	-1.56	1.59	-1.47
0.97	1.80	-1.47	1.64	-1.51
0.98	1.84	-1.73	1.67	-1.55
0.99	1.88	-1.96	1.72	-1.59
1.00	1.92	-2.51	1.76	-1.63
1.00	1.97	-3.00	1.80	-1.67
1.01	2.01	-3.00	1.85	-1.71
1.00	2.06	-3.00	1.90	-1.75
1.00	2.11	-2.51	1.94	-1.80
1.00	2.15	-3.00	1.99	-1.84
1.00	2.20	-2.51	2.03	-1.88
1.00	2.26	-2.51	2.10	-1.94
1.00	2.29	-2.61	2.12	-1.96
0.99	2.34	-1.96	2.17	-2.01

CALCULATION

Regression: About 90% of the Data (Log 0.1=-1)
The Non-Zero C/Co Start at 0.03
Intercept=loge p/(1-p 0.1514 >>>>> p= 25.85%
slope=(-)loge /(1-m)(1-p)= -0.9245 >>>>> m= 36.65%

Regression Statistics

Multiple R	0.99
R Square	0.97
Adjusted R Squar	0.93
Standard Error	0.05
Observations	24.00

Analysis of Variance

	df	Sum of Squares	Mean Square	F	Significance F
Regression	1.00	1.92	1.92	862.22	0.00
Residual	23.00	0.05	0.00		
Total	24.00	1.97			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
x1	-0.92	0.02	-61.49	0.00	-0.96	-0.89

RESERVOIR NO. 3 (198 ML/d) - REBHUN-ARGAMAN MODEL

REAL DATA C/Co	(To-T)/Td	log(1-C/Co)	CORRECTION (To-T)/Td	log(1-C/Co)
0.00	0.00	0.00	-0.03	0.02
0.00	0.00	0.00	-0.03	0.02
0.00	0.00	0.00	-0.03	0.02
0.00	0.00	0.00	-0.03	0.02
0.00	0.00	0.00	-0.03	0.02
0.01	0.01	0.00	-0.01	0.01
0.03	0.03	-0.01	0.00	0.00
0.15	0.04	-0.07	0.01	-0.01
0.24	0.01	-0.12	0.02	-0.02
0.24	0.07	-0.12	0.04	-0.03
0.26	0.08	-0.13	0.06	-0.03
0.27	0.10	-0.14	0.07	-0.04
0.27	0.13	-0.14	0.10	-0.06
0.29	0.16	-0.15	0.13	-0.08
0.33	0.19	-0.17	0.16	-0.10
0.40	0.22	-0.22	0.20	-0.13
0.39	0.26	-0.22	0.23	-0.15
0.41	0.27	-0.23	0.24	-0.15
0.42	0.33	-0.23	0.30	-0.19
0.46	0.34	-0.27	0.32	-0.20
0.53	0.37	-0.32	0.35	-0.22
0.53	0.41	-0.33	0.39	-0.24
0.54	0.44	-0.34	0.41	-0.26
0.55	0.45	-0.34	0.43	-0.27
0.58	0.50	-0.38	0.47	-0.30
0.59	0.53	-0.38	0.50	-0.32
0.62	0.56	-0.42	0.53	-0.34
0.61	0.59	-0.41	0.57	-0.36
0.63	0.62	-0.43	0.60	-0.38
0.63	0.64	-0.43	0.61	-0.39
0.65	0.69	-0.46	0.66	-0.42
0.68	0.72	-0.49	0.69	-0.44
0.66	0.75	-0.47	0.72	-0.46
0.68	0.78	-0.50	0.75	-0.48
0.72	0.81	-0.55	0.78	-0.50
0.70	0.84	-0.52	0.81	-0.52
0.72	0.89	-0.55	0.86	-0.55
0.73	0.90	-0.57	0.88	-0.56
0.77	0.93	-0.63	0.91	-0.58
0.76	0.96	-0.62	0.94	-0.60
0.76	1.00	-0.62	0.97	-0.62
0.78	1.03	-0.66	1.00	-0.63
0.80	1.07	-0.70	1.05	-0.66
0.79	1.09	-0.68	1.06	-0.67
0.79	1.12	-0.68	1.09	-0.69
0.80	1.15	-0.70	1.12	-0.71
0.80	1.18	-0.70	1.16	-0.73
0.81	1.21	-0.73	1.19	-0.75
0.81	1.24	-0.73	1.22	-0.77
0.83	1.27	-0.77	1.25	-0.79
0.83	1.31	-0.77	1.28	-0.81
0.84	1.34	-0.79	1.31	-0.83
0.83	1.37	-0.82	1.34	-0.85
0.86	1.40	-0.82	1.37	-0.87
0.86	1.43	-0.92	1.40	-0.99
0.88	1.46	-0.92	1.43	-0.91
0.88	1.49	-0.92	1.46	-0.93
0.89	1.52	-0.96	1.49	-0.95
0.89	1.55	-0.96	1.53	-0.97
0.90	1.58	-0.99	1.56	-0.99
0.89	1.63	-0.96	1.60	-1.02
0.90	1.65	-0.99	1.63	-1.03
0.89	1.67	-0.96	1.64	-1.04

CALCULATION

Regression Up to 90% of the Data (Log 0.1=-1)

The Non-Zero C/Co Start at 0.03

Intercept=log p/(1-p 0.0167 >>>>> p= 3.71%

slope=(-)log K(1-m)x(1-p)^ -0.6360 >>>>> m 28.97%

Regression Statistics

Multiple R	0.99
R Square	0.96
Adjusted R Squar	0.95
Standard Error	0.06
Observations	58.00

Analysis of Variance

	df	Sum of Squares	Mean Square	F	gnificance F
Regression	1.00	4.53	4.53	1486.96	0.00
Residual	57.00	0.17	0.00		
Total	58.00	4.71			

	Coefficients	Standard Error	t Statistic	P-value	Lower 95%	Upper 95%
Intercept	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
x1	-0.63	0.01	-91.13	0.00	-0.65	-0.62

RESERVOIRS NOS, 1,2,3 (170 ML/d) - REBHUN-ARGAMAN MODEL

REAL C/Co	(To-Ti)/Td	log(1-C/Co)	CORRECTION (To-Ti)/Td	log(C/Co)
0.01	0.00	0.00	-0.10	0.07
0.00	0.00	0.00	-0.10	0.07
0.00	0.01	0.00	-0.09	0.06
0.00	0.02	0.00	-0.08	0.06
0.01	0.03	0.00	-0.07	0.05
0.01	0.05	0.00	-0.05	0.03
0.01	0.06	0.00	-0.04	0.03
0.00	0.07	0.00	-0.03	0.02
0.01	0.08	0.00	-0.02	0.01
0.00	0.09	0.00	-0.01	0.01
0.00	0.10	0.00	0.00	0.00
0.04	0.12	-0.02	0.02	-0.01
0.04	0.12	-0.02	0.02	-0.01
0.08	0.13	-0.04	0.03	-0.02
0.11	0.14	-0.05	0.04	-0.03
0.09	0.15	-0.04	0.05	-0.03
0.11	0.16	-0.05	0.06	-0.04
0.11	0.17	-0.05	0.07	-0.05
0.11	0.18	-0.05	0.08	-0.06
0.10	0.19	-0.05	0.09	-0.06
0.14	0.20	-0.07	0.10	-0.07
0.14	0.22	-0.07	0.12	-0.08
0.18	0.23	-0.09	0.13	-0.09
0.20	0.24	-0.10	0.14	-0.10
0.20	0.25	-0.10	0.15	-0.10
0.22	0.26	-0.11	0.16	-0.11
0.22	0.27	-0.11	0.17	-0.12
0.23	0.28	-0.11	0.18	-0.13
0.23	0.29	-0.11	0.19	-0.13
0.28	0.30	-0.14	0.20	-0.14
0.28	0.31	-0.14	0.21	-0.15
0.29	0.32	-0.15	0.22	-0.15
0.29	0.33	-0.15	0.23	-0.16
0.34	0.34	-0.18	0.24	-0.17
0.34	0.35	-0.18	0.25	-0.17
0.39	0.36	-0.21	0.26	-0.18
0.39	0.37	-0.21	0.27	-0.19
0.39	0.39	-0.21	0.29	-0.20
0.39	0.40	-0.21	0.30	-0.21
0.41	0.41	-0.23	0.31	-0.22
0.43	0.42	-0.24	0.32	-0.22
0.43	0.43	-0.24	0.33	-0.23
0.44	0.44	-0.25	0.34	-0.24
0.43	0.45	-0.24	0.35	-0.24
0.43	0.46	-0.24	0.36	-0.25
0.44	0.47	-0.25	0.37	-0.26
0.43	0.48	-0.24	0.38	-0.26
0.47	0.49	-0.28	0.39	-0.27
0.48	0.50	-0.28	0.40	-0.28
0.50	0.51	-0.30	0.41	-0.29
0.49	0.52	-0.29	0.42	-0.29
0.50	0.54	-0.30	0.44	-0.31
0.51	0.55	-0.31	0.45	-0.31
0.52	0.56	-0.32	0.46	-0.32
0.53	0.57	-0.33	0.47	-0.33
0.51	0.58	-0.31	0.48	-0.33
0.52	0.59	-0.32	0.49	-0.34
0.53	0.60	-0.33	0.50	-0.35
0.54	0.61	-0.34	0.51	-0.36
0.59	0.62	-0.39	0.52	-0.36
0.60	0.63	-0.40	0.53	-0.37
0.61	0.64	-0.41	0.54	-0.38
0.61	0.65	-0.41	0.55	-0.38
0.61	0.66	-0.41	0.56	-0.39
0.61	0.67	-0.41	0.57	-0.40
0.62	0.69	-0.42	0.59	-0.41
0.63	0.70	-0.43	0.60	-0.42
0.63	0.71	-0.43	0.61	-0.42
0.63	0.72	-0.43	0.62	-0.43
0.63	0.73	-0.43	0.63	-0.44
0.65	0.74	-0.46	0.64	-0.45
0.65	0.75	-0.46	0.65	-0.45
0.64	0.76	-0.44	0.66	-0.46
0.67	0.77	-0.48	0.67	-0.47
0.68	0.79	-0.49	0.69	-0.48
0.68	0.79	-0.49	0.69	-0.48
0.69	0.80	-0.51	0.70	-0.49
0.70	0.81	-0.52	0.71	-0.49
0.70	0.83	-0.52	0.73	-0.51
0.70	0.84	-0.52	0.74	-0.52
0.71	0.85	-0.54	0.75	-0.52
0.71	0.86	-0.54	0.76	-0.53

CALCULATION

Regression: About 90% of the Data (Log 0.1=-1)

The Non-Zero C/Co Started at 0.03

Intercept=loge p/(1-p) 0.0697 >>>>> p= 13.8%

slope=(-)loge d/(1-d)(1-p)= -0.6967 >>>>> d= 27.7%

0.71	0.87	-0.54	0.77	-0.54
0.72	0.88	-0.55	0.78	-0.54
0.73	0.89	-0.57	0.79	-0.55
0.71	0.90	-0.54	0.80	-0.56
0.74	0.91	-0.59	0.81	-0.56
0.74	0.92	-0.59	0.82	-0.57
0.73	0.93	-0.57	0.83	-0.58
0.74	0.94	-0.59	0.84	-0.59
0.77	0.95	-0.64	0.85	-0.59
0.79	0.98	-0.68	0.88	-0.61
0.79	0.99	-0.68	0.89	-0.62
0.77	1.00	-0.64	0.90	-0.63
0.78	1.01	-0.66	0.91	-0.63
0.79	1.02	-0.68	0.92	-0.64
0.79	1.03	-0.68	0.93	-0.65
0.79	1.04	-0.68	0.94	-0.65
0.81	1.05	-0.72	0.95	-0.66
0.82	1.06	-0.74	0.96	-0.67
0.82	1.07	-0.74	0.97	-0.68
0.82	1.08	-0.74	0.98	-0.68
0.82	1.09	-0.74	0.99	-0.69
0.83	1.10	-0.77	1.00	-0.70
0.82	1.12	-0.74	1.02	-0.71
0.84	1.13	-0.80	1.03	-0.72
0.85	1.14	-0.82	1.04	-0.72
0.85	1.15	-0.82	1.05	-0.73
0.83	1.16	-0.77	1.06	-0.74
0.84	1.17	-0.80	1.07	-0.75
0.84	1.18	-0.80	1.08	-0.75
0.84	1.19	-0.80	1.09	-0.76
0.85	1.20	-0.82	1.10	-0.77
0.84	1.21	-0.80	1.11	-0.77
0.83	1.22	-0.77	1.12	-0.78
0.85	1.23	-0.82	1.13	-0.79
0.84	1.24	-0.80	1.14	-0.79
0.85	1.25	-0.82	1.15	-0.80
0.84	1.27	-0.80	1.17	-0.82
0.85	1.28	-0.82	1.18	-0.82
0.86	1.29	-0.85	1.19	-0.83
0.88	1.30	-0.92	1.20	-0.84
0.88	1.31	-0.92	1.21	-0.84
0.88	1.32	-0.92	1.22	-0.85
0.87	1.33	-0.89	1.23	-0.86
0.88	1.34	-0.92	1.24	-0.86
0.87	1.35	-0.89	1.25	-0.87
0.85	1.36	-0.82	1.26	-0.88
0.85	1.37	-0.82	1.27	-0.88
0.85	1.38	-0.82	1.28	-0.89
0.87	1.39	-0.89	1.29	-0.90
0.88	1.40	-0.92	1.30	-0.91
0.88	1.42	-0.92	1.32	-0.92
0.88	1.43	-0.92	1.33	-0.93
0.88	1.44	-0.92	1.34	-0.93
0.88	1.45	-0.92	1.35	-0.94
0.88	1.46	-0.92	1.36	-0.95
0.88	1.47	-0.92	1.37	-0.95
0.88	1.48	-0.92	1.38	-0.96
0.88	1.49	-0.92	1.39	-0.97
0.88	1.50	-0.92	1.40	-0.98
0.88	1.51	-0.92	1.41	-0.98
0.88	1.52	-0.92	1.42	-0.99
0.90	1.53	-1.00	1.43	-1.00
0.90	1.54	-1.00	1.44	-1.00
0.88	1.56	-0.92	1.46	-1.02
0.88	1.57	-0.92	1.47	-1.02
0.90	1.58	-1.00	1.48	-1.03
0.89	1.59	-0.96	1.49	-1.04
0.89	1.60	-0.96	1.50	-1.05
0.88	1.61	-0.92	1.51	-1.05
0.89	1.62	-0.96	1.52	-1.06
0.90	1.63	-1.00	1.53	-1.07
0.90	1.64	-1.00	1.54	-1.07
0.91	1.65	-1.05	1.55	-1.08
0.91	1.66	-1.05	1.56	-1.09
0.90	1.67	-1.00	1.57	-1.09
0.91	1.68	-1.05	1.58	-1.10
0.91	1.69	-1.05	1.59	-1.11
0.91	1.71	-1.05	1.61	-1.12
0.91	1.72	-1.05	1.62	-1.13
0.91	1.73	-1.05	1.63	-1.14
0.93	1.75	-1.15	1.65	-1.15
0.93	1.76	-1.15	1.66	-1.16
0.92	1.77	-1.10	1.67	-1.16
0.92	1.78	-1.10	1.68	-1.17
0.92	1.79	-1.10	1.69	-1.18
0.92	1.80	-1.10	1.70	-1.18
0.90	1.81	-1.00	1.71	-1.19

0.91	1.82	-1.05	1.72	-1.20
0.93	1.83	-1.15	1.73	-1.21
0.93	1.85	-1.15	1.75	-1.22
0.93	1.86	-1.15	1.76	-1.23
0.92	1.87	-1.10	1.77	-1.23
0.92	1.88	-1.10	1.78	-1.24
0.92	1.89	-1.10	1.79	-1.25
0.93	1.90	-1.15	1.80	-1.25
0.92	1.91	-1.10	1.81	-1.26
0.94	1.92	-1.22	1.82	-1.27
0.94	1.93	-1.22	1.83	-1.27
0.94	1.94	-1.22	1.84	-1.28
0.95	1.95	-1.30	1.85	-1.29
0.94	1.96	-1.22	1.86	-1.30
0.95	1.97	-1.30	1.87	-1.30
0.94	1.99	-1.22	1.89	-1.32
0.95	2.00	-1.30	1.90	-1.32
0.95	2.01	-1.30	1.91	-1.33
0.95	2.02	-1.30	1.92	-1.34
0.94	2.03	-1.22	1.93	-1.34
0.93	2.04	-1.15	1.94	-1.35
0.95	2.05	-1.30	1.95	-1.36
0.95	2.06	-1.30	1.96	-1.37
0.95	2.07	-1.30	1.97	-1.37
0.95	2.08	-1.30	1.98	-1.38
0.95	2.09	-1.30	1.99	-1.39
0.96	2.10	-1.40	2.00	-1.39
0.95	2.12	-1.30	2.02	-1.41
0.94	2.13	-1.22	2.03	-1.41
0.95	2.14	-1.30	2.04	-1.42
0.95	2.15	-1.30	2.05	-1.43
0.95	2.16	-1.30	2.06	-1.44
0.95	2.17	-1.30	2.07	-1.44
0.95	2.18	-1.30	2.08	-1.45
0.95	2.19	-1.30	2.09	-1.46
0.95	2.20	-1.30	2.10	-1.46
0.95	2.21	-1.30	2.11	-1.47
0.95	2.22	-1.30	2.12	-1.48
0.95	2.23	-1.30	2.13	-1.48
0.95	2.24	-1.30	2.14	-1.49
0.95	2.26	-1.30	2.16	-1.50
0.95	2.27	-1.30	2.17	-1.51
0.95	2.28	-1.30	2.18	-1.52
0.95	2.29	-1.30	2.19	-1.53
0.95	2.30	-1.30	2.20	-1.53
0.95	2.31	-1.30	2.21	-1.54
0.95	2.32	-1.30	2.22	-1.55
0.96	2.33	-1.40	2.23	-1.55
0.96	2.34	-1.40	2.24	-1.56
0.96	2.35	-1.40	2.25	-1.57
0.95	2.36	-1.30	2.26	-1.57
0.96	2.37	-1.40	2.27	-1.58
0.96	2.38	-1.40	2.28	-1.59
0.96	2.40	-1.40	2.30	-1.60
0.96	2.41	-1.40	2.31	-1.61
0.96	2.42	-1.40	2.32	-1.62
0.96	2.43	-1.40	2.33	-1.62
0.96	2.44	-1.40	2.34	-1.63
0.97	2.45	-1.52	2.35	-1.64
0.96	2.47	-1.40	2.37	-1.65
0.96	2.48	-1.40	2.38	-1.66
0.96	2.48	-1.40	2.38	-1.66
0.97	2.50	-1.52	2.40	-1.67
0.96	2.51	-1.40	2.41	-1.68
0.97	2.52	-1.52	2.42	-1.69
0.97	2.54	-1.52	2.44	-1.70
0.98	2.55	-1.70	2.45	-1.71
0.98	2.56	-1.70	2.46	-1.71
0.98	2.58	-1.70	2.48	-1.73
0.96	2.59	-1.40	2.49	-1.73
0.97	2.60	-1.52	2.50	-1.74
0.98	2.61	-1.70	2.51	-1.75
0.98	2.62	-1.70	2.52	-1.76
0.98	2.63	-1.70	2.53	-1.76
0.97	2.64	-1.52	2.54	-1.77
0.97	2.65	-1.52	2.55	-1.78
0.98	2.66	-1.70	2.56	-1.78
0.98	2.68	-1.70	2.58	-1.80
0.98	2.69	-1.70	2.59	-1.80
0.98	2.70	-1.70	2.60	-1.81
0.98	2.71	-1.70	2.61	-1.82
0.98	2.72	-1.70	2.62	-1.83
0.98	2.73	-1.70	2.63	-1.83
0.98	2.74	-1.70	2.64	-1.84
0.98	2.75	-1.70	2.65	-1.85
0.99	2.76	-2.00	2.66	-1.85
0.98	2.77	-1.70	2.67	-1.86

0.98	2.78	-1.70	2.68	-1.87
0.99	2.79	-2.00	2.69	-1.87
0.99	2.80	-2.00	2.70	-1.88
0.98	2.82	-1.70	2.72	-1.89
0.98	2.83	-1.70	2.73	-1.90
0.98	2.84	-1.70	2.74	-1.91
0.98	2.85	-1.70	2.75	-1.92
0.98	2.86	-1.70	2.76	-1.92
0.98	2.87	-1.70	2.77	-1.93
0.99	2.88	-2.00	2.78	-1.94
0.99	2.89	-2.00	2.79	-1.94
0.98	2.90	-1.70	2.80	-1.95
0.99	2.91	-2.00	2.81	-1.96
0.98	2.92	-1.70	2.82	-1.96
0.98	2.93	-1.70	2.83	-1.97
0.98	2.95	-1.70	2.85	-1.99
0.98	2.96	-1.70	2.86	-1.99
0.98	2.97	-1.70	2.87	-2.00
0.98	2.98	-1.70	2.88	-2.01
0.98	2.99	-1.70	2.89	-2.01
0.99	3.00	-2.00	2.90	-2.02
0.99	3.01	-2.00	2.91	-2.03
0.99	3.02	-2.00	2.92	-2.03
1.00	3.03	-3.00	2.93	-2.04
1.00	3.04	-3.00	2.94	-2.05
1.00	3.05	-3.00	2.95	-2.06
0.99	3.06	-2.00	2.96	-2.06
1.00	3.07	-3.00	2.97	-2.07
1.00	3.09	-3.00	2.99	-2.08
1.00	3.10	-3.00	3.00	-2.09
1.00	3.11	-3.00	3.01	-2.10
1.00	3.12	-3.00	3.02	-2.10
1.00	3.13	-3.00	3.03	-2.11
1.00	3.14	-3.00	3.04	-2.12
1.00	3.15	-3.00	3.05	-2.12
1.00	3.16	-3.00	3.06	-2.13
1.00	3.17	-3.00	3.07	-2.14
1.00	3.18	-3.00	3.08	-2.15
1.00	3.19	-3.00	3.09	-2.15
1.00	3.20	-3.00	3.10	-2.16
1.00	3.21	-3.00	3.11	-2.17
1.00	3.23	-3.00	3.13	-2.18
1.00	3.24	-3.00	3.14	-2.19
1.00	3.25	-3.00	3.15	-2.19
1.00	3.26	-3.00	3.16	-2.20
1.00	3.27	-3.00	3.17	-2.21
1.00	3.28	-3.00	3.18	-2.22
1.00	3.29	-3.00	3.19	-2.22
1.00	3.30	-3.00	3.20	-2.23
1.00	3.31	-3.00	3.21	-2.24
1.00	3.32	-3.00	3.22	-2.24
1.00	3.33	-3.00	3.23	-2.25
1.00	3.37	-3.00	3.27	-2.28

Regression Statistics

Multiple R	0.99
R Square	0.98
Adjusted R Square	0.98
Standard Error	0.04
Observations	144.00

Analysis of Variance

	df	Sum of Squares	Mean Square	F	ignificance F
Regression	1.00	13.48	13.48	8806.28	0.00
Residual	143.00	0.22	0.00		
Total	144.00	13.70			

	Coefficients	Standard Error	t Statistic	Pvalue	Lower 95%	Upper 95%
Intercept	0.00	#N/A	#N/A	#N/A	#N/A	#N/A
x1	-0.70	0.00	-190.22	0.00	-0.70	-0.69

APPENDIX 4: JET MODEL

RESERVOIR NO. 2 (141 ML/d) - JET MODEL

Vol. of tank	28570	m3
qo(initial flow)	97.92	m3/min
do(imaginary pipe diam)	1.00	m
Ao(m^2)	0.79	m^2
uo(initial velocity)	124.73	m/min

JETS

x1 (core length) = 18*ro	9.00	m
Imaginary plane=	145	m
water level=	3.9	m
angle for jet core =	2	

ux = 9* (do/x)*uo *exp(-74 * (r/x)^2)

Cx =Co* 7* (do/x) * exp(-54* (r/x)^2)

		x (m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
angle (deg)	0.0	x'(m)=	0.0	10.0	15.0	20.0	25.0	30.0	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		ux(m/min)=	124.7	112.3	74.8	56.1	44.9	37.4	32.1	28.1	24.9	22.5	20.4	18.7	17.3	16.0	15.0	14.0
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.4	1.6	1.9	2.2	2.5	2.9
	1.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.3	1.4
		ux(m/min)=	124.7	109.8	73.2	54.9	43.9	36.6	31.4	27.4	24.4	22.0	20.0	18.3	16.9	15.7	14.6	13.7
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.2	1.4	1.7	2.0	2.3	2.6	2.9
	2.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7	1.9	2.1	2.3	2.4	2.6	2.8
		ux(m/min)=	124.7	102.6	68.4	51.3	41.0	34.2	29.3	25.6	22.8	20.5	18.7	17.1	15.8	14.7	13.7	12.8
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.0	1.2	1.5	1.8	2.1	2.4	2.8	3.1
	3.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6	2.9	3.1	3.4	3.7	3.9	4.2
		ux(m/min)=	124.7	91.6	61.1	45.8	36.7	30.5	26.2	22.9	20.4	18.3	16.7	15.3	14.1	13.1	12.2	11.5
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4
		tx(min)=	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.1	1.4	1.7	2.0	2.3	2.7	3.1	3.5
	4.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5	3.8	4.2	4.5	4.9	5.2	5.6
		ux(m/min)=	124.7	78.2	52.1	39.1	31.3	26.1	22.3	19.6	17.4	15.6	14.2	13.0	12.0	11.2	10.4	9.8
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5
		tx(min)=	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.3	1.6	2.0	2.3	2.7	3.2	3.6	4.1
	5.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.9	1.3	1.7	2.2	2.6	3.1	3.5	3.9	4.4	4.8	5.2	5.7	6.1	6.6	7.0
		ux(m/min)=	124.7	83.8	62.5	31.9	25.5	21.3	18.2	15.9	14.2	12.8	11.6	10.6	9.8	9.1	8.5	8.0
		dt x(min)=	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6
		tx(min)=	0.0	0.1	0.2	0.3	0.5	0.7	1.0	1.3	1.6	2.0	2.4	2.8	3.3	3.9	4.4	5.0
	6.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.7	5.3	5.8	6.3	6.8	7.4	7.9	8.4
		ux(m/min)=	124.7	49.6	33.1	24.8	19.8	16.5	14.2	12.4	11.0	9.9	9.0	8.3	7.6	7.1	6.6	6.2
		dt x(min)=	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8
		tx(min)=	0.0	0.1	0.2	0.4	0.6	0.9	1.2	1.6	2.0	2.5	3.1	3.6	4.3	5.0	5.7	6.5
	7.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	66	71	76	81
		r(m)=	0.0	1.2	1.8	2.5	3.1	3.7	4.3	4.9	5.5	6.1	6.7	7.4	8.0	8.6	9.2	9.8
		ux(m/min)=	124.7	36.6	24.6	18.4	14.7	12.3	10.5	9.2	8.2	7.4	6.7	6.1	5.7	5.3	4.9	4.6
		dt x(min)=	0.0	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.8	0.9	0.9	1.0	1.1
		tx(min)=	0.0	0.1	0.3	0.5	0.8	1.2	1.6	2.2	2.7	3.4	4.1	4.9	5.7	6.7	7.7	8.7
	8.0	x'(m)=	0	10	15	20	25	30	35	40	45	51	56	61	66	71	76	81
		r(m)=	0.0	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0	7.7	8.4	9.1	9.8	10.5	11.2
		ux(m/min)=	124.7	124.7	17.4	13.0	10.4	8.7	7.4	6.5	5.8	5.2	4.7	4.3	4.0	3.7	3.5	3.3
		dt x(min)=	0.0	0.1	0.1	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5
		tx(min)=	0.0	0.1	0.2	0.5	0.9	1.4	2.1	2.8	3.6	4.5	5.5	6.7	7.9	9.2	10.6	12.1
	9.0	x'(m)=	0	10	15	20	25	30	35	41	46	51	56	61	66	71	76	81
		r(m)=	0.0	1.6	2.4	3.2	4.0	4.7	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.1	11.9	12.7
		ux(m/min)=	124.7	17.8	11.7	8.8	7.0	5.9	5.0	4.4	3.9	3.5	3.2	2.9	2.7	2.5	2.3	2.2
		dt x(min)=	0.0	0.1	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5	1.7	1.8	1.9	2.1	2.2
		tx(min)=	0.0	0.1	0.5	1.0	1.6	2.4	3.3	4.4	5.6	7.0	8.5	10.2	12.0	13.9	16.0	18.2
	10.0	x'(m)=	0	10	15	20	25	30	36	41	46	51	56	61	66	71	76	81
		r(m)=	0.0	1.8	2.6	3.5	4.4	5.3	6.2	7.0	7.9	8.8	9.7	10.6	11.5	12.3	13.2	14.1
		ux(m/min)=	124.7	11.3	7.5	5.6	4.5	3.8	3.2	2.8	2.5	2.3	2.0	1.9	1.7	1.6	1.5	1.4
		dt x(min)=	0.0	0.1	0.5	0.8	1.0	1.2	1.5	1.7	1.9	2.1	2.4	2.6	2.8	3.0	3.3	3.5
		tx(min)=	0.0	0.1	0.7	1.5	2.5	3.7	5.2	6.8	8.7	10.9	13.2	15.8	18.6	21.7	24.9	28.4

85	90	95	100	105	110	115	120	125	130	135	140	145
85	90	95	100	105	110	115	120	125	130	135	140	145
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0
13.2	12.5	11.8	11.2	10.7	10.2	9.8	9.4	9.0	8.64	8.3	8.0	7.7
0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.57	0.6	0.6	0.6
3.2	3.6	4.0	4.5	4.9	5.4	5.9	6.4	7.0	7.6	8.1	8.8	9.4
85	90	95	100	105	110	115	120	125	130	135	140	145
1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.27	2.4	2.4	2.5
12.9	12.2	11.6	11.0	10.5	10.0	9.5	9.1	8.8	8.44	8.1	7.8	7.6
0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.58	0.6	0.6	0.6
3.3	3.7	4.1	4.6	5.0	5.5	6.1	6.6	7.1	7.7	8.3	9.0	9.6
85	90	95	100	105	110	115	120	125	130	135	140	145
3.0	3.1	3.3	3.5	3.7	3.8	4.0	4.2	4.4	4.54	4.7	4.9	5.1
12.1	11.4	10.8	10.3	9.8	9.3	8.9	8.5	8.2	7.89	7.6	7.3	7.1
0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.62	0.6	0.7	0.7
3.6	4.0	4.4	4.9	5.4	5.9	6.5	7.0	7.6	8.3	8.9	9.6	10.3
85	90	95	100	105	110	115	120	125	130	135	140	145
4.5	4.7	5.0	5.2	5.5	5.8	6.0	6.3	6.5	6.81	7.1	7.3	7.6
10.8	10.2	9.6	9.2	8.7	8.3	8.0	7.6	7.3	7.05	6.8	6.5	6.3
0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.70	0.7	0.8	0.8
4.0	4.4	5.0	5.5	6.0	6.6	7.2	7.9	8.6	9.3	10.0	10.7	11.5
85	90	95	100	105	110	115	120	125	130	135	140	145
5.9	6.3	6.6	7.0	7.3	7.7	8.0	8.4	8.7	9.09	9.4	9.8	10.1
9.2	8.7	8.2	7.8	7.4	7.1	6.8	6.5	6.3	6.02	5.8	5.6	5.4
0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.82	0.8	0.9	0.9
4.6	5.2	5.8	6.4	7.1	7.8	8.5	9.2	10.0	10.8	11.7	12.6	13.5
85	90	95	100	105	110	115	120	126	131	136	141	146
7.4	7.9	8.3	8.7	9.2	9.6	10.1	10.5	10.9	11.37	11.8	12.2	12.7
7.5	7.1	6.7	6.4	6.1	5.8	5.5	5.3	5.1	4.90	4.7	4.6	4.4
0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.0	1.00	1.0	1.1	1.1
5.7	6.4	7.1	7.9	8.7	9.5	10.4	11.3	12.3	13.3	14.4	15.4	16.6
85	91	96	101	106	111	116	121	126	131	136	141	146
8.9	9.5	10.0	10.5	11.0	11.6	12.1	12.6	13.1	13.66	14.2	14.7	15.2
5.8	5.5	5.2	5.0	4.7	4.5	4.3	4.1	4.0	3.82	3.7	3.5	3.4
0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.29	1.3	1.4	1.4
7.3	8.2	9.1	10.1	11.2	12.3	13.4	14.6	15.8	17.1	18.5	19.9	21.3
86	91	96	101	106	111	116	121	126	131	136	141	146
10.4	11.0	11.7	12.3	12.9	13.5	14.1	14.7	15.3	15.95	16.6	17.2	17.8
4.3	4.1	3.9	3.7	3.5	3.3	3.2	3.1	2.9	2.83	2.7	2.6	2.5
1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.74	1.8	1.9	1.9
9.6	11.0	12.3	13.6	15.0	16.5	18.0	19.7	21.3	23.1	24.9	26.8	28.7
86	91	96	101	106	111	116	121	126	131	136	141	147
11.9	12.6	13.3	14.0	14.7	15.5	16.2	16.9	17.6	18.26	19.0	19.7	20.4
3.1	2.9	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.01	1.9	1.9	1.8
1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.47	2.6	2.7	2.8
13.7	15.4	17.2	19.1	21.0	23.1	25.3	27.6	29.9	32.4	35.0	37.6	40.4
86	91	96	101	106	111	117	122	127	132	137	142	147
13.5	14.2	15.0	15.8	16.6	17.4	18.2	19.0	19.8	20.58	21.4	22.2	23.0
2.1	2.0	1.8	1.8	1.7	1.6	1.5	1.5	1.4	1.35	1.3	1.3	1.2
2.4	2.5	2.7	2.8	3.0	3.1	3.2	3.4	3.5	3.67	3.8	4.0	4.1
20.6	23.1	25.8	28.6	31.6	34.7	37.9	41.3	44.8	48.5	52.3	56.3	60.4
86	91	97	102	107	112	117	122	127	132	137	142	147
15.0	15.9	16.7	17.6	18.5	19.4	20.3	21.1	22.0	22.91	23.8	24.7	25.6
1.3	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.87	0.8	0.8	0.8
3.7	3.9	4.2	4.4	4.6	4.8	5.1	5.3	5.5	5.75	6.0	6.2	6.4
32.1	36.1	40.3	44.8	49.3	54.1	59.2	64.5	70.0	75.7	81.7	87.9	94.3

Inlet		
T inlet	C/Co	Toutlet
17	0.00	26
18	0.00	27
19	0.00	28
20	0.00	29
21	0.00	30
22	0.00	31
23	0.00	32
24	0.00	33
25	0.00	34
26	0.06	35
27	0.12	36
28	0.17	37
29	0.29	38
30	0.34	39
31	0.42	40
32	0.50	41
33	0.60	42
34	0.68	43
35	0.76	44
36	0.78	45
37	0.82	46
38	0.84	47
39	0.88	48
40	0.91	49
41	0.92	50
42	0.92	51
43	0.96	52
44	0.97	53
45	0.98	54
46	0.99	55
47	0.99	56
48	1.00	57
49	1.00	58
50	1.00	59
51	1.00	60
52	1.00	61
53	1.00	62
END		63
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		97

Outlet at 145m

angle (deg)=	0.0			1.0			2.0			3.0			4.0		
r(m)=	0.0			2.5			5.1			7.6			10.1		
1/2 A(m^2)=	0.1			10.0			30.2			50.4			70.7		
ux(m/min)=	7.7			7.6			7.1			6.3			5.4		
tx(min)=	9.4			9.6			10.3			11.5			13.5		
	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass
	0.00	26	0.00												
	0.00	27	0.00	0.00	27	-0.01	0.00	27	-0.03						
	0.00	28	0.00	0.00	28	-0.01	0.00	28	-0.03						
	0.00	29	0.00	0.00	29	-0.01	0.00	29	-0.03	0.00	29	-0.04			
	0.00	30	0.00	0.00	30	-0.01	0.00	30	-0.03	0.00	30	-0.04	0.00	30	-0.05
	0.00	31	0.00	0.00	31	-0.01	0.00	31	-0.03	0.00	31	-0.04	0.00	31	-0.05
	0.00	32	0.00	0.00	32	-0.01	0.00	32	-0.03	0.00	32	-0.04	0.00	32	-0.05
	0.00	33	0.00	0.00	33	-0.01	0.00	33	-0.03	0.00	33	-0.04	0.00	33	-0.05
	0.00	34	0.00	0.00	34	-0.01	0.00	34	-0.03	0.00	34	-0.04	0.00	34	-0.05
	0.00	35	0.00	0.00	35	0.11	0.00	35	-0.03	0.00	35	-0.04	0.00	35	-0.05
	0.01	36	0.00	0.00	36	0.34	0.00	36	0.83	0.00	36	0.45	0.00	36	-0.05
	0.01	37	0.00	0.01	37	0.55	0.01	37	1.27	0.00	37	0.82	0.00	37	-0.05
	0.01	38	0.01	0.01	38	0.88	0.01	38	1.80	0.00	38	1.77	0.00	38	0.51
	0.02	39	0.01	0.01	39	1.20	0.01	39	3.07	0.01	39	3.14	0.00	39	1.53
	0.02	40	0.01	0.02	40	1.45	0.02	40	3.59	0.01	40	3.89	0.00	40	2.44
	0.03	41	0.01	0.02	41	1.75	0.02	41	4.44	0.01	41	5.39	0.01	41	3.89
	0.03	42	0.01	0.02	42	2.09	0.02	42	5.29	0.01	42	6.37	0.01	42	5.26
	0.03	43	0.01	0.03	43	2.44	0.03	43	6.34	0.02	43	7.73	0.01	43	6.36
	0.04	44	0.01	0.03	44	2.74	0.03	44	7.19	0.02	44	8.94	0.02	44	7.69
	0.04	45	0.02	0.04	45	2.93	0.04	45	8.03	0.03	45	10.29	0.02	45	9.19
	0.04	46	0.02	0.04	46	3.04	0.04	46	8.25	0.03	46	11.02	0.02	46	10.68
	0.04	47	0.02	0.04	47	3.16	0.04	47	8.67	0.03	47	11.91	0.03	47	12.01
	0.04	48	0.02	0.04	48	3.27	0.04	48	8.88	0.03	48	12.21	0.03	48	12.81
	0.05	49	0.02	0.04	49	3.40	0.04	49	9.30	0.03	49	12.81	0.03	49	13.32
	0.05	50	0.02	0.04	50	3.48	0.04	50	9.62	0.04	50	13.19	0.03	50	13.81
	0.05	51	0.02	0.05	51	3.50	0.04	51	9.73	0.04	51	13.56	0.03	51	14.32
	0.05	52	0.02	0.05	52	3.58	0.04	52	9.73	0.04	52	13.77	0.03	52	14.89
	0.05	53	0.02	0.05	53	3.67	0.04	53	10.15	0.04	53	14.16	0.03	53	15.22
	0.05	54	0.02	0.05	54	3.71	0.05	54	10.25	0.04	54	14.24	0.03	54	15.29
	0.05	55	0.02	0.05	55	3.75	0.05	55	10.36	0.04	55	14.80	0.03	55	15.85
	0.05	56	0.02	0.05	56	3.76	0.05	56	10.47	0.04	56	14.75	0.04	56	16.05
	0.05	57	0.02	0.05	57	3.78	0.05	57	10.47	0.04	57	14.83	0.04	57	16.21
	0.05	58	0.02	0.05	58	3.80	0.05	58	10.57	0.04	58	14.98	0.04	58	16.38
	0.05	59	0.02	0.05	59	3.80	0.05	59	10.57	0.04	59	14.98	0.04	59	16.46
	0.05	60	0.02	0.05	60	3.80	0.05	60	10.57	0.04	60	15.05	0.04	60	16.55
	0.05	61	0.02	0.05	61	3.80	0.05	61	10.57	0.04	61	15.05	0.04	61	16.62
	0.05	62	0.02	0.05	62	3.80	0.05	62	10.57	0.04	62	15.05	0.04	62	16.62
	0.05		0.02	0.05	63	3.80	0.05	63	10.57	0.04	63	15.05	0.04	63	16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04	64	15.05	0.04	64	16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04	65	15.05	0.04	65	16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04	66	16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62
	0.05		0.02	0.05		3.80	0.05		10.57	0.04		15.05	0.04		16.62

98	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
99	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
100	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
101	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
102	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
103	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
104	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
105	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
106	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
107	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
108	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
109	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
110	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
111	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
112	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
113	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
114	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
115	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
116	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
117	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
118	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
119	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
120	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
121	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
122	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
123	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
124	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
125	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
126	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
127	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
128	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
129	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
130	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
131	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
132	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
133	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
134	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
135	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
136	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
137	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
138	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62
139	0.05	0.02	0.05	3.80	0.05	10.57	0.04	15.05	0.04	16.62

5.0 12.7 91.2 4.4 16.6			6.0 15.2 111.9 3.4 21.3			7.0 17.8 132.9 2.5 28.7			8.0 20.4 154.2 1.8 40.4			9.0 23.0 175.9 1.2 60.4			10.0 25.6 198.0 0.8 94.3			Complete Total Flux		Jet Core (2°) Total Flux	
C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Mass	C/Co	Mass
																		0.00	0.0	0.00	0.00
																		0.00	0.0	0.00	-0.04
																		0.00	0.0	0.00	-0.04
																		0.00	-0.1	0.00	-0.04
																		0.00	-0.1	0.00	-0.04
																		0.00	-0.1	0.00	-0.04
																		0.00	-0.1	0.00	-0.04
																		0.00	-0.1	0.00	-0.04
																		0.00	-0.2	0.00	-0.04
0.00	34	-0.04																0.00	-0.1	0.00	0.08
0.00	35	-0.04																0.01	1.3	0.01	0.98
0.00	36	-0.04																0.03	2.7	0.02	1.82
0.00	37	-0.04																0.05	4.9	0.03	2.68
0.00	38	-0.04	0.00	38	-0.04													0.10	9.4	0.04	4.27
0.00	39	0.48	0.00	39	-0.04													0.13	12.3	0.05	5.05
0.00	40	0.99	0.00	40	-0.04													0.17	16.8	0.06	6.20
0.00	41	1.41	0.00	41	-0.04													0.22	21.4	0.08	7.39
0.00	42	2.42	0.00	42	-0.04													0.27	26.6	0.09	8.79
0.00	43	3.29	0.00	43	0.40													0.32	31.8	0.10	9.94
0.00	44	4.39	0.00	44	0.83													0.38	37.1	0.11	10.98
0.01	45	5.42	0.00	45	1.18													0.43	42.1	0.12	11.30
0.01	46	7.12	0.00	46	2.02	0.00	46	-0.03										0.48	46.9	0.12	11.84
0.01	47	8.15	0.00	47	2.73	0.00	47	0.30										0.52	50.8	0.12	12.17
0.01	48	9.40	0.00	48	3.64	0.00	48	0.62										0.56	54.4	0.13	12.72
0.02	49	10.14	0.00	49	4.49	0.00	49	0.88										0.60	58.7	0.13	13.12
0.02	50	11.19	0.01	50	5.89	0.00	50	1.50										0.63	61.5	0.14	13.24
0.02	51	11.93	0.01	51	6.74	0.00	51	1.76										0.66	64.8	0.14	13.32
0.02	52	12.84	0.01	52	7.76	0.00	52	2.18										0.69	67.4	0.14	13.84
0.03	53	13.24	0.01	53	8.36	0.00	53	2.60										0.71	69.5	0.14	13.98
0.03	54	13.61	0.02	54	9.22	0.00	54	3.12										0.73	71.7	0.14	14.12
0.03	55	13.75	0.02	55	9.82	0.00	55	3.80										0.76	74.5	0.15	14.25
0.03	56	14.37	0.02	56	10.56	0.00	56	4.47										0.78	76.2	0.15	14.27
0.03	57	14.67	0.02	57	10.89	0.00	57	4.78	0.00	57	0.59							0.80	78.3	0.15	14.39
0.03	58	14.83	0.02	58	11.19	0.01	58	5.48	0.00	58	1.01							0.81	79.0	0.15	14.39
0.03	59	14.91	0.02	59	11.30	0.01	59	5.80	0.00	59	1.18							0.83	80.8	0.15	14.39
0.03	60	15.20	0.02	60	11.82	0.01	60	6.34	0.00	60	1.46							0.84	82.0	0.15	14.39
0.03	61	15.36	0.02	61	12.06	0.01	61	6.82	0.00	61	1.74							0.85	83.1	0.15	14.39
0.03	62	15.43	0.02	62	12.19	0.01	62	7.29	0.00	62	2.09							0.86	83.8	0.15	14.39
0.03	63	15.50	0.02	63	12.26	0.01	63	7.62	0.00	63	2.37							0.87	84.9	0.15	14.39
0.03	64	15.50	0.03	64	12.49	0.02	64	8.16	0.00	64	2.65							0.87	85.3	0.15	14.39
0.03	65	15.57	0.03	65	12.62	0.02	65	8.30	0.00	65	2.72							0.88	85.8	0.15	14.39
0.03	66	15.57	0.03	66	12.67	0.02	66	8.51	0.00	66	3.03							0.88	86.3	0.15	14.39
0.03	67	15.57	0.03	67	12.73	0.02	67	8.65	0.00	67	3.25							0.89	86.7	0.15	14.39
0.03	68	15.57	0.03	68	12.73	0.02	68	8.81	0.00	68	3.53							0.89	87.4	0.15	14.39
0.03	69	15.57	0.03	69	12.79	0.02	69	8.99	0.00	69	3.95							0.89	87.6	0.15	14.39
0.03	70	15.57	0.03	70	12.79	0.02	70	9.03	0.01	70	4.12							0.90	87.8	0.15	14.39
0.03		15.57	0.03	71	12.79	0.02	71	9.03	0.01	71	4.33							0.90	88.3	0.15	14.39
0.03		15.57	0.03	72	12.79	0.02	72	9.20	0.01	72	4.69							0.91	88.7	0.15	14.39
0.03		15.57	0.03	73	12.79	0.02	73	9.24	0.01	73	4.99							0.91	88.9	0.15	14.39
0.03		15.57	0.03	74	12.79	0.02	74	9.28	0.01	74	5.24							0.91	89.2	0.15	14.39
0.03		15.57	0.03		12.79	0.02	75	9.32	0.01	75	5.49							0.91	89.3	0.15	14.39
0.03		15.57	0.03		12.79	0.02	76	9.32	0.01	76	5.54							0.93	91.2	0.15	14.39
0.03		15.57	0.03		12.79	0.02	77	9.36	0.01	77	5.68	0.00	77	1.73				0.93	91.3	0.15	14.39
0.03		15.57	0.03		12.79	0.02	78	9.36	0.01	78	5.73	0.00	78	1.77				0.93	91.5	0.15	14.39
0.03		15.57	0.03		12.79	0.02	79	9.36	0.01	79	5.84	0.00	79	1.85				0.94	91.6	0.15	14.39
0.03		15.57	0.03		12.79	0.02	80	9.36	0.01	80	5.92	0.00	80	1.92				0.94	91.7	0.15	14.39
0.03		15.57	0.03		12.79	0.02	81	9.36	0.01	81	5.95	0.00	81	1.94				0.94	91.7	0.15	14.39
0.03		15.57	0.03		12.79	0.02	82	9.36	0.01	82	5.95	0.00	82	1.94				0.94	91.9	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	83	6.05	0.00	83	2.02				0.94	91.9	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	84	6.08	0.00	84	2.04				0.94	92.0	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	85	6.11	0.00	85	2.06				0.94	92.1	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	86	6.13	0.00	86	2.18				0.94	92.2	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	87	6.13	0.00	87	2.27				0.94	92.3	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	88	6.16	0.00	88	2.37				0.94	92.5	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	89	6.16	0.00	89	2.56				0.95	92.6	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	90	6.16	0.00	90	2.64				0.95	92.7	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	91	6.16	0.00	91	2.78				0.95	92.8	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	92	6.16	0.01	92	2.88				0.95	93.0	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02	93	6.16	0.01	93	3.04				0.95	93.1	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02		6.16	0.01	94	3.16				0.95	93.2	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02		6.16	0.01	95	3.29				0.95	93.3	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02		6.16	0.01	96	3.32				0.95	93.3	0.15	14.39
0.03		15.57	0.03		12.79	0.02		9.36	0.02		6.16	0.01	97	3.38							

0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01	98	3.41				0.95	93.4	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01	99	3.47				0.95	93.4	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01	100	3.52				0.95	93.5	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01	101	3.54				0.95	93.5	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01	102	3.54				0.95	93.5	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01	103	3.60				0.96	93.5	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01	104	3.61				0.96	93.6	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01	105	3.63				0.96	93.6	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63				0.96	93.6	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63				0.96	93.6	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63				0.96	93.6	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63				0.96	93.6	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63				0.96	93.6	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	111	1.13	0.97	94.7	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	112	1.13	0.97	94.7	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	113	1.13	0.97	94.7	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	114	1.13	0.97	94.7	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	115	1.13	0.97	94.7	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	116	1.13	0.97	94.7	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	117	1.13	0.97	94.7	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	118	1.13	0.97	94.7	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	119	1.13	0.97	94.7	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	120	1.18	0.97	94.8	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	121	1.23	0.97	94.8	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	122	1.27	0.97	94.8	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	123	1.37	0.97	94.9	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	124	1.41	0.97	95.0	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	125	1.47	0.97	95.1	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	126	1.54	0.97	95.1	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.00	127	1.62	0.97	95.2	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	128	1.68	0.97	95.3	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	129	1.75	0.97	95.3	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	130	1.77	0.97	95.3	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	131	1.80	0.97	95.4	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	132	1.81	0.97	95.4	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	133	1.85	0.97	95.4	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	134	1.87	0.97	95.4	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	135	1.88	0.97	95.5	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	136	1.88	0.97	95.5	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	137	1.91	0.98	95.5	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	138	1.92	0.98	95.5	0.15	14.39
0.03	15.57	0.03	12.79	0.02	9.36	0.02	6.16	0.01		3.63	0.01	139	1.93	0.98	95.5	0.15	14.39

RESERVOIR NO. 2 (167 ML/d) - JET MODEL

vol. of tank	32060	m3
qo(initial flow)	115.97	m3/min
do(imaginary pipe diam)	1.10	m
Ao(m^2)	0.95	m^2
uo(initial velocity)	122.10	m/min

JETS

x1 (core length) = 15*ro =	9.90	m
imaginary plane=	145	m
water level=	4.0	m
angle for jet core =	2	

ux = 8* (do/x)*uo *exp(-74 * (r/x)^2)

Cx =Co* 7* (do/x) * exp(-64* (r/x)^2)

		x (m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
angle (deg)	0.0	x'(m)=	0.0	10.0	15.0	20.0	25.0	30.0	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		ux(m/min)=	122.1	122.1	80.8	60.4	48.3	40.3	34.5	30.2	26.9	24.2	22.0	20.1	18.6	17.3	16.1	15.1
		dt x(min)=	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.8	2.1	2.4	2.7
	1.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.3	1.4
		ux(m/min)=	122.1	122.1	78.8	59.1	47.3	39.4	33.8	29.5	26.3	23.6	21.5	19.7	18.2	16.9	15.8	14.8
		dt x(min)=	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.3	1.6	1.8	2.1	2.4	2.7
	2.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7	1.9	2.1	2.3	2.4	2.6	2.8
		ux(m/min)=	122.1	122.1	73.6	55.2	44.2	36.8	31.6	27.6	24.5	22.1	20.1	18.4	17.0	15.8	14.7	13.8
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.8	0.9	1.2	1.4	1.7	1.9	2.2	2.6	2.9
	3.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6	2.9	3.1	3.4	3.7	3.9	4.2
		ux(m/min)=	122.1	122.1	65.8	49.3	39.5	32.9	28.2	24.7	21.9	19.7	17.9	16.4	15.2	14.1	13.2	12.3
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.0	1.3	1.5	1.8	2.2	2.5	2.9	3.3
	4.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5	3.8	4.2	4.5	4.9	5.2	5.6
		ux(m/min)=	122.1	122.1	56.1	42.1	33.7	28.1	24.1	21.1	18.7	16.8	15.3	14.0	13.0	12.0	11.2	10.5
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
		tx(min)=	0.0	0.1	0.1	0.2	0.4	0.5	0.7	0.9	1.2	1.5	1.8	2.1	2.5	2.9	3.3	3.8
	5.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	0.9	1.3	1.7	2.2	2.6	3.1	3.5	3.9	4.4	4.8	5.2	5.7	6.1	6.6	7.0
		ux(m/min)=	122.1	122.1	45.8	34.3	27.5	22.9	19.6	17.2	15.3	13.7	12.5	11.4	10.6	9.8	9.2	8.6
		dt x(min)=	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6
		tx(min)=	0.0	0.1	0.1	0.3	0.4	0.6	0.9	1.1	1.4	1.8	2.2	2.6	3.1	3.5	4.1	4.6
	6.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
		r(m)=	0.0	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.7	5.3	5.8	6.3	6.8	7.4	7.9	8.4
		ux(m/min)=	122.1	122.1	35.6	26.7	21.4	17.8	15.3	13.4	11.9	10.7	9.7	8.9	8.2	7.6	7.1	6.7
		dt x(min)=	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7
		tx(min)=	0.0	0.1	0.1	0.3	0.5	0.8	1.1	1.4	1.8	2.3	2.8	3.3	3.9	4.5	5.2	5.9
	7.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	71	76	81
		r(m)=	0.0	1.2	1.8	2.5	3.1	3.7	4.3	4.9	5.5	6.1	6.7	7.4	8.0	8.6	9.2	9.8
		ux(m/min)=	122.1	122.1	26.4	19.8	15.9	13.2	11.3	9.9	8.8	7.9	7.2	6.6	6.1	5.7	5.3	5.0
		dt x(min)=	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.7	0.8	0.9	0.9	1.0
		tx(min)=	0.0	0.1	0.2	0.4	0.7	1.0	1.4	1.9	2.4	3.0	3.7	4.4	5.2	6.1	7.0	8.0
	8.0	x'(m)=	0	10	15	20	25	30	35	40	45	51	56	61	66	71	76	81
		r(m)=	0.0	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0	7.7	8.4	9.1	9.8	10.5	11.2
		ux(m/min)=	122.1	122.1	18.7	14.0	11.2	9.4	8.0	7.0	6.2	5.6	5.1	4.7	4.3	4.0	3.7	3.5
		dt x(min)=	0.0	0.1	0.1	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.9	1.0	1.1	1.2	1.3	1.4
		tx(min)=	0.0	0.1	0.2	0.5	0.9	1.4	1.9	2.6	3.4	4.2	5.2	6.2	7.3	8.5	9.8	11.2
	9.0	x'(m)=	0	10	15	20	25	30	36	41	46	51	56	61	66	71	76	81
		r(m)=	0.0	1.6	2.4	3.2	4.0	4.7	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.1	11.9	12.7
		ux(m/min)=	122.1	122.1	12.6	9.5	7.6	6.3	5.4	4.7	4.2	3.8	3.4	3.2	2.9	2.7	2.5	2.4
		dt x(min)=	0.0	0.1	0.1	0.5	0.6	0.7	0.9	1.0	1.1	1.3	1.4	1.5	1.7	1.8	1.9	2.1
		tx(min)=	0.0	0.1	0.2	0.6	1.2	1.9	2.8	3.8	4.9	6.2	7.6	9.1	10.8	12.6	14.6	16.6
	10.0	x'(m)=	0	10	15	20	25	30	36	41	46	51	56	61	66	71	76	81
		r(m)=	0.0	1.8	2.6	3.5	4.4	5.3	6.2	7.0	7.9	8.8	9.7	10.6	11.5	12.3	13.2	14.1
		ux(m/min)=	122.1	122.1	8.1	6.1	4.9	4.0	3.5	3.0	2.7	2.4	2.2	2.0	1.9	1.7	1.6	1.5
		dt x(min)=	0.0	0.1	0.1	0.7	0.9	1.1	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
		tx(min)=	0.0	0.1	0.2	0.9	1.8	3.0	4.3	5.9	7.6	9.6	11.8	14.2	16.8	19.7	22.7	25.9

85	90	95	100	105	110	115	120	125	130	135	140	145
85	90	95	100	105	110	115	120	125	130	135	140	145
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.2	13.4	12.7	12.1	11.5	11.0	10.5	10.1	9.7	9.3	9.0	8.8	8.3
0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6
3.0	3.4	3.8	4.2	4.6	5.0	5.5	6.0	6.5	7.0	7.6	8.1	8.7
85	90	95	100	105	110	115	120	125	130	135	140	145
1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.4	2.5
13.9	13.1	12.4	11.8	11.3	10.7	10.3	9.8	9.5	9.1	8.8	8.4	8.2
0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6
3.1	3.5	3.8	4.3	4.7	5.1	5.6	6.1	6.6	7.2	7.7	8.3	8.9
85	90	95	100	105	110	115	120	125	130	135	140	145
3.0	3.1	3.3	3.5	3.7	3.8	4.0	4.2	4.4	4.5	4.7	4.9	5.1
13.0	12.3	11.6	11.0	10.5	10.0	9.6	9.2	8.8	8.5	8.2	7.9	7.6
0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6
3.3	3.7	4.1	4.6	5.0	5.5	6.0	6.5	7.1	7.7	8.3	8.9	9.5
85	90	95	100	105	110	115	120	125	130	135	140	145
4.5	4.7	5.0	5.2	5.5	5.8	6.0	6.3	6.5	6.8	7.1	7.3	7.6
11.6	11.0	10.4	9.9	9.4	9.0	8.6	8.2	7.9	7.6	7.3	7.0	6.8
0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7
3.7	4.1	4.6	5.1	5.6	6.1	6.7	7.3	7.9	8.6	9.3	10.0	10.7
85	90	95	100	105	110	115	120	125	130	135	140	145
5.9	6.3	6.6	7.0	7.3	7.7	8.0	8.4	8.7	9.1	9.4	9.8	10.1
9.9	9.4	8.9	8.4	8.0	7.7	7.3	7.0	6.7	6.5	6.2	6.0	5.8
0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8
4.3	4.8	5.4	5.9	6.6	7.2	7.9	8.6	9.3	10.0	10.8	11.7	12.5
85	90	95	100	105	110	115	120	126	131	136	141	146
7.4	7.9	8.3	8.7	9.2	9.6	10.1	10.5	10.9	11.4	11.8	12.2	12.7
8.1	7.6	7.2	6.9	6.5	6.2	6.0	5.7	5.5	5.3	5.1	4.9	4.7
0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0
5.2	5.9	6.6	7.3	8.0	8.8	9.6	10.5	11.4	12.3	13.3	14.3	15.3
86	91	96	101	106	111	116	121	126	131	136	141	146
8.9	9.5	10.0	10.5	11.0	11.6	12.1	12.6	13.1	13.7	14.2	14.7	15.2
6.3	5.9	5.6	5.3	5.1	4.9	4.6	4.5	4.3	4.1	4.0	3.8	3.7
0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.2	1.3	1.3
6.7	7.5	8.4	9.3	10.3	11.3	12.4	13.5	14.6	15.8	17.1	18.4	19.7
86	91	96	101	106	111	116	121	126	131	136	141	146
10.4	11.0	11.7	12.3	12.9	13.5	14.1	14.7	15.3	16.0	16.6	17.2	17.8
4.7	4.4	4.2	4.0	3.8	3.6	3.4	3.3	3.2	3.1	2.9	2.8	2.7
1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.6	1.7	1.7	1.8
9.0	10.1	11.3	12.5	13.8	15.2	16.6	18.1	19.7	21.3	23.0	24.7	26.5
86	91	96	101	106	111	116	121	126	131	136	141	147
11.9	12.6	13.3	14.0	14.7	15.5	16.2	16.9	17.6	18.3	19.0	19.7	20.4
3.3	3.1	3.0	2.8	2.7	2.6	2.4	2.3	2.2	2.2	2.1	2.0	1.9
1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6
12.7	14.3	16.0	17.7	19.6	21.5	23.5	25.6	27.8	30.1	32.5	35.0	37.5
86	91	96	101	106	111	117	122	127	132	137	142	147
13.8	14.2	15.0	15.8	16.6	17.4	18.2	19.0	19.8	20.6	21.4	22.2	23.0
2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.6	1.5	1.5	1.4	1.4	1.3
2.2	2.3	2.5	2.6	2.7	2.9	3.0	3.1	3.3	3.4	3.5	3.7	3.8
18.8	21.2	23.7	26.3	29.0	31.9	34.9	38.0	41.3	44.7	48.3	52.0	55.8
86	91	97	102	107	112	117	122	127	132	137	142	147
15.0	15.9	16.7	17.6	18.5	19.4	20.3	21.1	22.0	22.9	23.8	24.7	25.6
1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.9	0.8
3.5	3.7	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.5	5.8	6.0
29.4	33.0	36.9	41.0	45.3	49.8	54.5	59.4	64.5	69.9	75.4	81.2	87.1

Inlet			Outlet at 145m															
			angle (deg)=	0.0			1.0			2.0			3.0			4.0		
			r(m)=	0.0			2.5			5.1			7.8			10.1		
			1/2 A(m^2)=	0.1			10.0			30.2			80.4			70.7		
			t₀(min)=	8.3			8.2			7.8			8.8			8.8		
			t₀(min)=	8.7			8.9			9.5			10.7			12.5		
T inlet	C/Co	Toutlet		C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass
17	0.00	26		0.00	26	0.00	0.00	26	-0.01									
18	0.01	27		0.00	27	0.00	0.00	27	0.03	0.00	27	0.02						
19	0.01	28		0.00	28	0.00	0.00	28	0.06	0.00	28	0.13	0.00	28	0.03			
20	0.01	29		0.00	29	0.00	0.00	29	0.03	0.00	29	0.12	0.00	29	0.18			
21	0.01	30		0.00	30	0.00	0.00	30	0.06	0.00	30	0.13	0.00	30	0.17	0.00	30	0.12
22	0.03	31		0.00	31	0.00	0.00	31	0.14	0.00	31	0.29	0.00	31	0.18	0.00	31	0.11
23	0.11	32		0.01	32	0.00	0.01	32	0.49	0.00	32	0.89	0.00	32	0.41	0.00	32	0.28
24	0.19	33		0.01	33	0.00	0.01	33	0.84	0.01	33	1.88	0.00	33	1.28	0.00	33	0.38
25	0.23	34		0.01	34	0.01	0.01	34	1.03	0.01	34	2.80	0.01	34	2.85	0.00	34	1.27
26	0.45	35		0.02	35	0.01	0.02	35	2.03	0.01	35	4.29	0.01	35	3.71	0.00	35	2.23
27	0.61	36		0.03	36	0.01	0.03	36	2.73	0.02	36	6.84	0.01	36	6.16	0.00	36	3.39
28	0.71	37		0.04	37	0.02	0.04	37	3.19	0.03	37	8.24	0.02	37	9.48	0.01	37	6.43
29	0.79	38		0.04	38	0.02	0.04	38	3.54	0.04	38	9.37	0.03	38	11.75	0.01	38	8.44
30	0.79	39		0.04	39	0.02	0.04	39	3.54	0.04	39	9.84	0.03	39	13.35	0.02	39	11.58
31	0.81	40		0.04	40	0.02	0.04	40	3.65	0.04	40	9.99	0.04	40	14.00	0.03	40	13.81
32	0.84	41		0.05	41	0.02	0.05	41	3.78	0.04	41	10.33	0.04	41	14.23	0.03	41	14.78
33	0.87	42		0.05	42	0.02	0.05	42	3.92	0.04	42	10.71	0.04	42	14.72	0.03	42	15.72
34	0.90	43		0.05	43	0.02	0.05	43	4.05	0.04	43	11.09	0.04	43	15.25	0.03	43	16.04
35	0.92	44		0.05	44	0.02	0.05	44	4.14	0.05	44	11.40	0.04	44	15.79	0.03	44	16.58
36	0.93	45		0.05	45	0.02	0.05	45	4.19	0.05	45	11.58	0.04	45	16.23	0.03	45	17.17
37	0.94	46		0.05	46	0.02	0.05	46	4.23	0.05	46	11.71	0.04	46	16.49	0.04	46	17.66
38	0.95	47		0.05	47	0.02	0.05	47	4.26	0.05	47	11.83	0.04	47	16.67	0.04	47	18.03
39	0.96	48		0.05	48	0.02	0.05	48	4.32	0.05	48	11.96	0.04	48	16.85	0.04	48	18.32
40	0.97	49		0.05	49	0.02	0.05	49	4.37	0.05	49	12.08	0.04	49	17.03	0.04	49	18.62
41	0.98	50		0.05	50	0.02	0.05	50	4.41	0.05	50	12.21	0.05	50	17.20	0.04	50	18.72
42	0.98	51		0.05	51	0.02	0.05	51	4.41	0.05	51	12.27	0.05	51	17.38	0.04	51	18.91
43	0.98	52		0.05	52	0.02	0.05	52	4.41	0.05	52	12.27	0.05	52	17.47	0.04	52	19.11
44	0.99	53		0.05	53	0.02	0.05	53	4.48	0.05	53	12.33	0.05	53	17.47	0.04	53	19.20
45	0.99	54		0.05	54	0.02	0.05	54	4.48	0.05	54	12.40	0.05	54	17.56	0.04	54	19.30
46	0.99	55		0.05	55	0.02	0.05	55	4.48	0.05	55	12.40	0.05	55	17.65	0.04	55	19.40
47	0.99	56		0.05	56	0.02	0.05	56	4.48	0.05	56	12.40	0.05	56	17.65	0.04	56	19.40
48	0.99	57		0.05	57	0.02	0.05	57	4.48	0.05	57	12.40	0.05	57	17.65	0.04	57	19.49
49	0.99	58		0.05	58	0.02	0.05	58	4.48	0.05	58	12.40	0.05	58	17.65	0.04	58	19.49
50	0.99	59		0.05	59	0.02	0.05	59	4.48	0.05	59	12.40	0.05	59	17.65	0.04	59	19.49
51	0.99	60		0.05	60	0.02	0.05	60	4.48	0.05	60	12.40	0.05	60	17.65	0.04	60	19.49
52	0.99	61		0.05	61	0.02	0.05	61	4.48	0.05	61	12.40	0.05	61	17.65	0.04	61	19.49
53	1.00	62		0.06	62	0.02	0.05	62	4.50	0.05	62	12.48	0.05	62	17.65	0.04	62	19.49
END		63		0.06		0.02	0.06		4.50	0.05	63	12.52	0.05	63	17.74	0.04	63	19.49
		64		0.06		0.02	0.06		4.50	0.06		12.52	0.05	64	17.82	0.04	64	19.60
		65		0.06		0.02	0.06		4.50	0.05		12.52	0.05		17.82	0.04	65	19.60
		66		0.06		0.02	0.05		4.50	0.05		12.52	0.05		17.82	0.04	66	19.69
		67		0.06		0.02	0.06		4.50	0.05		12.52	0.05		17.82	0.04		19.69
		68		0.06		0.02	0.05		4.50	0.05		12.52	0.05		17.82	0.04		19.69
		69		0.06		0.02	0.06		4.50	0.05		12.52	0.05		17.82	0.04		19.69
		70		0.06		0.02	0.05		4.50	0.05		12.52	0.05		17.82	0.04		19.69
		71		0.06		0.02	0.06		4.50	0.05		12.52	0.05		17.82	0.04		19.69
		72		0.06		0.02	0.05		4.50	0.05		12.52	0.05		17.82	0.04		19.69
		73		0.06		0.02	0.06		4.50	0.06		12.52	0.05		17.82	0.04		19.69
		74		0.06		0.02	0.06		4.50	0.05		12.52	0.05		17.82	0.04		19.69
		75		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		76		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		77		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		78		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		79		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		80		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		81		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		82		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		83		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		84		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		85		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		86		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		87		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		88		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		89		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		90		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		91		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		92		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		93		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69
		94		0.06		0.02	0.06		4.50	0.06		12.52	0.06		17.82	0.04		19.69

95	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
96	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
97	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
98	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
99	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
100	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
101	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
102	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
103	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
104	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
105	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
106	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
107	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
108	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
109	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
110	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
111	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
112	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
113	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
114	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
115	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
116	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
117	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
118	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
119	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
120	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
121	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
122	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
123	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69
124	0.06	0.02	0.05	4.50	0.05	12.52	0.05	17.82	0.04	19.69

5.0			6.0			7.0			8.0			9.0			10.0				
12.2			15.2			17.8			20.4			23.0			25.6				
74.1			129.0			132.9			154.2			175.9			198.0			Complete	Jet Core (2°)
4.9			3.7			2.7			1.9			1.3			0.8			Total Flux	Total Flux
14.3			19.7			26.5			37.5			55.8			87.1				
C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co Mass	C/Co Mass
																		0.00 0.0	0.00 0.0
																		0.00 0.0	0.00 0.0
																		0.00 0.2	0.00 0.2
																		0.00 0.3	0.00 0.1
																		0.00 0.5	0.00 0.2
0.00	31	0.03																0.01 0.8	0.00 0.4
0.00	32	0.16																0.02 2.2	0.01 1.4
0.00	33	0.15																0.04 4.8	0.02 2.7
0.00	34	0.16																0.07 7.7	0.03 3.6
0.00	35	0.36																0.11 12.8	0.05 6.3
0.00	36	1.12																0.17 20.0	0.08 9.4
0.00	37	2.31	0.00	37	1.07													0.27 30.8	0.10 11.8
0.01	38	3.22	0.00	38	1.92													0.33 38.3	0.11 12.9
0.01	39	5.36	0.00	39	2.42													0.40 46.1	0.12 13.4
0.02	40	8.24	0.00	40	4.60													0.47 54.3	0.12 13.7
0.02	41	10.19	0.00	41	6.22													0.51 59.5	0.12 14.1
0.03	42	11.57	0.00	42	7.39													0.55 64.1	0.13 14.6
0.03	43	12.13	0.00	43	8.79													0.58 67.4	0.13 15.2
0.03	44	12.33	0.01	44	9.41	0.00	44	1.14										0.61 70.8	0.13 15.6
0.03	45	12.75	0.01	45	10.00	0.00	45	1.44										0.63 73.4	0.14 15.8
0.03	46	13.21	0.01	46	12.09	0.00	46	2.88										0.67 78.3	0.14 16.0
0.03	47	13.67	0.02	47	13.83	0.00	47	3.78										0.71 81.9	0.14 16.1
0.03	48	14.06	0.02	48	14.76	0.00	48	4.45										0.73 84.7	0.14 16.3
0.03	49	14.28	0.02	49	15.59	0.00	49	5.02										0.75 86.9	0.14 16.5
0.03	50	14.44	0.02	50	15.69	0.00	50	5.39										0.76 88.1	0.14 16.6
0.03	51	14.59	0.02	51	15.98	0.00	51	5.92										0.77 89.5	0.14 16.7
0.03	52	14.75	0.02	52	16.32	0.01	52	6.32										0.78 90.7	0.14 16.7
0.03	53	14.90	0.03	53	16.67	0.01	53	7.60										0.80 92.6	0.15 16.8
0.04	54	15.05	0.03	54	17.01	0.01	54	8.54										0.81 94.3	0.15 16.9
0.04	55	15.13	0.03	55	17.27	0.02	55	9.17	0.00	55	2.92							0.85 98.4	0.15 16.9
0.04	56	15.13	0.03	56	17.35	0.02	56	9.61	0.00	56	3.27							0.86 99.3	0.15 16.9
0.04	57	15.21	0.03	57	17.43	0.02	57	9.67	0.00	57	3.30							0.86 99.6	0.15 16.9
0.04	58	15.28	0.03	58	17.61	0.02	58	9.85	0.00	58	3.37							0.86 100.1	0.15 16.9
0.04	59	15.28	0.03	59	17.69	0.02	59	10.06	0.00	59	3.52							0.87 100.6	0.15 16.9
0.04	60	15.28	0.03	60	17.77	0.02	60	10.27	0.00	60	3.70							0.87 101.0	0.15 16.9
0.04	61	15.28	0.03	61	17.85	0.02	61	10.47	0.00	61	4.07							0.88 101.7	0.15 16.9
0.04	62	15.28	0.03	62	17.85	0.02	62	10.57	0.00	62	4.39							0.88 102.2	0.15 17.0
0.04	63	15.28	0.03	63	17.85	0.02	63	10.62	0.00	63	4.57							0.88 102.6	0.15 17.0
0.04	64	15.28	0.03	64	17.93	0.02	64	10.73	0.01	64	5.32							0.89 103.7	0.15 17.0
0.04	65	15.28	0.03	65	17.93	0.02	65	10.78	0.01	65	5.84							0.90 104.3	0.15 17.0
0.04	66	15.36	0.03	66	17.93	0.02	66	10.83	0.01	66	6.21							0.90 104.9	0.15 17.0
0.04	67	15.43	0.03	67	18.03	0.02	67	10.88	0.01	67	6.50							0.91 105.4	0.15 17.0
0.04		15.43	0.03	68	18.03	0.02	68	10.93	0.01	68	6.54							0.91 105.5	0.15 17.0
0.04		15.43	0.03	69	18.03	0.02	69	10.93	0.01	69	6.61							0.91 105.6	0.15 17.0
0.04		15.43	0.03	70	18.03	0.02	70	10.93	0.01	70	6.71							0.91 105.7	0.15 17.0
0.04		15.43	0.03	71	18.03	0.02	71	10.98	0.02	71	6.84							0.91 105.9	0.15 17.0
0.04		15.43	0.03	72	18.03	0.02	72	10.98	0.02	72	6.94							0.91 105.9	0.15 17.0
0.04		15.43	0.03	73	18.11	0.02	73	11.04	0.02	73	7.00	0.00	73	2.29				0.94 108.4	0.15 17.0
0.04		15.43	0.03		18.11	0.02	74	11.04	0.02	74	7.03	0.00	74	2.33				0.94 108.5	0.15 17.0
0.04		15.43	0.03		18.11	0.02	75	11.04	0.02	75	7.06	0.00	75	2.38				0.94 108.6	0.15 17.0
0.04		15.43	0.03		18.11	0.02	76	11.04	0.02	76	7.10	0.00	76	2.38				0.94 108.8	0.15 17.0
0.04		15.43	0.03		18.11	0.02	77	11.04	0.02	77	7.13	0.00	77	2.43				0.94 108.7	0.15 17.0
0.04		15.43	0.03		18.11	0.02	78	11.04	0.02	78	7.16	0.00	78	2.48				0.94 108.8	0.15 17.0
0.04		15.43	0.03		18.11	0.02	79	11.04	0.02	79	7.19	0.00	79	2.85				0.94 109.0	0.15 17.0
0.04		15.43	0.03		18.11	0.02	80	11.09	0.02	80	7.23	0.00	80	2.79				0.94 109.2	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	81	7.23	0.00	81	2.87				0.94 109.3	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	82	7.26	0.01	82	3.30				0.95 109.8	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	83	7.26	0.01	83	3.59				0.95 110.0	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	84	7.26	0.01	84	3.77				0.95 110.2	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	85	7.26	0.01	85	3.92				0.95 110.4	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	86	7.26	0.01	86	3.92				0.95 110.4	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	87	7.26	0.01	87	3.98				0.95 110.4	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	88	7.26	0.01	88	4.02				0.95 110.5	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	89	7.26	0.01	89	4.07				0.95 110.5	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	90	7.26	0.01	90	4.13				0.95 110.6	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02	91	7.30	0.01	91	4.19				0.95 110.7	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02		7.30	0.01	92	4.21				0.95 110.7	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02		7.30	0.01	93	4.22				0.95 110.7	0.15 17.0
0.04		15.43	0.03		18.11	0.02		11.09	0.02		7.30	0.01	94	4.24				0.95 110.7	0.15 17.0

0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	95	4.26				0.98	110.8	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	96	4.28				0.98	110.8	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	97	4.30				0.98	110.8	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	98	4.30				0.98	110.8	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	99	4.30				0.98	110.8	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	100	4.32				0.98	110.8	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	101	4.32				0.98	110.8	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	102	4.32				0.98	110.8	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	103	4.32				0.98	110.8	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	104	4.32	0.00	104	1.35	0.97	112.2	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	105	4.32	0.00	105	1.36	0.97	112.2	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	106	4.32	0.00	106	1.37	0.97	112.2	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	107	4.32	0.00	107	1.36	0.97	112.2	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	108	4.32	0.00	108	1.37	0.97	112.2	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01	109	4.33	0.00	109	1.40	0.97	112.2	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.00	110	1.47	0.97	112.3	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.00	111	1.55	0.97	112.4	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.00	112	1.59	0.97	112.4	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.00	113	1.80	0.97	112.6	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	114	1.95	0.97	112.8	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	115	2.05	0.97	112.9	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	116	2.12	0.97	113.0	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	117	2.12	0.97	113.0	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	118	2.15	0.97	113.0	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	119	2.18	0.97	113.0	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	120	2.21	0.97	113.0	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	121	2.23	0.97	113.1	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	122	2.25	0.98	113.1	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	123	2.26	0.98	113.1	0.15	17.0
0.04	15.43	0.03	18.11	0.02	11.09	0.02	7.30	0.01		4.33	0.01	124	2.27	0.98	113.1	0.15	17.0

RESERVOIR NO. 3 (179 ML/d) - JET MODEL

vol. of tank	35178	m3
qo(initial flow)	124.31	m3/min
do(imaginary pipe diam)	0.70	m
Ao(m^2)	0.38	m^2
uo(initial velocity)	323.17	m/min

JETS

x1 (core length) = 18*ro	6.30	m
imaginary plane=	175	m
water level=	3.6	m
angle for jet core =	2	°

ux = 9* (do/x)*uo *exp(-74 * (r/x)^2)

Cx =Co* 7* (do/x) * exp(-54* (r/x)^2)

		x (m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
angle (deg)	0.0	x'(m)=	0.0	10.0	15.0	20.0	25.0	30.0	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		ux(m/min)=	323.2	203.6	135.7	101.8	81.4	67.9	58.2	50.9	45.2	40.7	37.0	33.9	31.3	29.1	27.1	25.4	24.0
		dt x(min)=	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
		tx(min)=	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.2	1.4	1.6	1.8
	1.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.3	1.4	1.5
		ux(m/min)=	323.2	199.1	132.7	99.5	79.6	66.4	56.9	49.8	44.2	39.8	36.2	33.2	30.6	28.4	26.5	24.9	23.4
		dt x(min)=	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
		tx(min)=	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.6	1.8
	2.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7	1.9	2.1	2.3	2.4	2.6	2.8	3.0
		ux(m/min)=	323.2	188.0	124.0	93.0	74.4	62.0	53.2	46.5	41.3	37.2	33.8	31.0	28.6	26.6	24.8	23.3	21.9
		dt x(min)=	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
		tx(min)=	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.3	1.5	1.7	1.9
	3.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6	2.9	3.1	3.4	3.7	3.9	4.2	4.5
		ux(m/min)=	323.2	186.2	110.8	83.1	66.5	55.4	47.5	41.5	36.9	33.2	30.2	27.7	25.6	23.7	22.2	20.8	19.6
		dt x(min)=	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
		tx(min)=	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.1	1.3	1.5	1.7	1.9	2.2
	4.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5	3.8	4.2	4.5	4.9	5.2	5.6	5.9
		ux(m/min)=	323.2	141.8	94.6	70.9	56.7	47.3	40.5	35.5	31.5	28.4	25.8	23.6	21.8	20.3	18.9	17.7	16.7
		dt x(min)=	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
		tx(min)=	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.3	2.6
	5.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.9	1.3	1.7	2.2	2.6	3.1	3.5	3.9	4.4	4.8	5.2	5.7	6.1	6.6	7.0	7.4
		ux(m/min)=	323.2	115.6	77.1	57.8	46.2	38.5	33.0	28.9	25.7	23.1	21.0	19.3	17.8	16.5	15.4	14.5	13.6
		dt x(min)=	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
		tx(min)=	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.1	1.3	1.6	1.8	2.1	2.4	2.8	3.1
	6.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.7	5.3	5.8	6.3	6.8	7.4	7.9	8.4	8.9
		ux(m/min)=	323.2	90.0	60.0	45.0	36.0	30.0	25.7	22.5	20.0	18.0	16.4	15.0	13.8	12.9	12.0	11.2	10.6
		dt x(min)=	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
		tx(min)=	0.0	0.0	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.4	1.7	2.0	2.3	2.7	3.1	3.6	4.0
	7.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	66	71	76	81	86
		r(m)=	0.0	1.2	1.8	2.5	3.1	3.7	4.3	4.9	5.5	6.1	6.7	7.4	8.0	8.6	9.2	9.8	10.4
		ux(m/min)=	323.2	66.8	44.5	33.4	26.7	22.3	19.1	16.7	14.8	13.4	12.1	11.1	10.3	9.5	8.9	8.3	7.9
		dt x(min)=	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6
		tx(min)=	0.0	0.1	0.1	0.3	0.4	0.6	0.9	1.2	1.5	1.8	2.2	2.7	3.1	3.7	4.2	4.8	5.4
	8.0	x'(m)=	0	10	15	20	25	30	35	40	45	51	56	61	66	71	76	81	86
		r(m)=	0.0	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0	7.7	8.4	9.1	9.8	10.5	11.2	11.9
		ux(m/min)=	323.2	47.3	31.5	23.6	18.9	15.8	13.5	11.8	10.5	9.5	8.6	7.9	7.3	6.8	6.3	5.9	5.6
		dt x(min)=	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9
		tx(min)=	0.0	0.1	0.2	0.4	0.6	0.9	1.2	1.6	2.1	2.6	3.2	3.8	4.4	5.2	5.9	6.8	7.6
	9.0	x'(m)=	0	10	15	20	25	30	35	41	46	51	56	61	66	71	76	81	86
		r(m)=	0.0	1.6	2.4	3.2	4.0	4.7	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.1	11.9	12.7	13.5
		ux(m/min)=	323.2	31.9	21.2	15.9	12.7	10.6	9.1	8.0	7.1	6.4	5.8	5.3	4.9	4.6	4.2	4.0	3.7
		dt x(min)=	0.0	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1.0	1.1	1.2	1.2	1.3
		tx(min)=	0.0	0.1	0.2	0.5	0.9	1.3	1.8	2.4	3.1	3.8	4.7	5.6	6.6	7.6	8.8	10.0	11.3
	10.0	x'(m)=	0	10	15	20	25	30	36	41	46	51	56	61	66	71	76	81	86
		r(m)=	0.0	1.8	2.6	3.5	4.4	5.3	6.2	7.0	7.9	8.8	9.7	10.6	11.5	12.3	13.2	14.1	15.0
		ux(m/min)=	323.2	11.9	13.6	10.2	8.2	6.8	5.8	5.1	4.5	4.1	3.7	3.4	3.1	2.9	2.7	2.6	2.4
		dt x(min)=	0.0	0.1	0.4	0.4	0.6	0.7	0.8	0.9	1.1	1.2	1.3	1.4	1.6	1.7	1.8	1.9	2.0
		tx(min)=	0.0	0.1	0.5	0.9	1.4	2.1	2.9	3.8	4.9	6.1	7.4	8.8	10.4	12.0	13.8	15.8	17.8

90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175
90	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.6	21.4	20.4	19.4	18.5	17.7	17.0	16.3	15.7	15.1	14.5	14.0	13.6	13.1	12.7	12.3	12.0	11.6
0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4
2.0	2.2	2.6	2.7	3.0	3.3	3.5	3.8	4.2	4.5	4.8	5.2	5.5	5.9	6.3	6.7	7.1	7.5
90	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**
1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1
22.1	21.0	19.9	19.0	18.1	17.3	16.6	15.9	15.3	14.7	14.2	13.7	13.3	12.8	12.4	12.1	11.7	11.4
0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2.0	2.3	2.5	2.8	3.0	3.3	3.6	3.9	4.3	4.6	4.9	5.3	5.7	6.0	6.4	6.8	7.3	7.7
90	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**
3.1	3.3	3.5	3.7	3.8	4.0	4.2	4.4	4.5	4.7	4.9	5.1	5.2	5.4	5.6	5.8	5.9	6.1
20.7	19.6	18.6	17.7	16.9	16.2	15.5	14.9	14.3	13.8	13.3	12.8	12.4	12.0	11.6	11.3	10.9	10.6
0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5
2.2	2.4	2.7	3.0	3.3	3.6	3.9	4.2	4.5	4.9	5.3	5.7	6.1	6.5	6.9	7.3	7.8	8.2
90	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**
4.7	5.0	5.2	5.5	5.8	6.0	6.3	6.5	6.8	7.1	7.3	7.6	7.9	8.1	8.4	8.6	8.9	9.2
18.5	17.5	16.6	15.8	15.1	14.5	13.8	13.3	12.8	12.3	11.9	11.5	11.1	10.7	10.4	10.1	9.8	9.5
0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5
2.4	2.7	3.0	3.3	3.6	4.0	4.3	4.7	5.1	5.5	5.9	6.3	6.8	7.2	7.7	8.2	8.7	9.2
90	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**
6.3	6.6	7.0	7.3	7.7	8.0	8.4	8.7	9.1	9.4	9.8	10.1	10.5	10.8	11.2	11.5	11.9	12.2
15.6	14.9	14.2	13.5	12.9	12.3	11.8	11.3	10.9	10.5	10.1	9.8	9.5	9.2	8.9	8.6	8.3	8.1
0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6
2.9	3.2	3.5	3.9	4.3	4.7	5.1	5.5	6.0	6.4	6.9	7.4	7.9	8.5	9.0	9.6	10.2	10.8
90	**95**	**100**	**105**	**110**	**115**	**120**	**126**	**131**	**136**	**141**	**146**	**151**	**156**	**161**	**166**	**171**	**176**
7.9	8.3	8.7	9.2	9.6	10.1	10.5	10.9	11.4	11.8	12.2	12.7	13.1	13.6	14.0	14.4	14.9	15.3
12.8	12.2	11.6	11.0	10.5	10.1	9.6	9.2	8.9	8.6	8.3	8.0	7.7	7.5	7.2	7.0	6.8	6.6
0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7
3.5	3.9	4.3	4.8	5.2	5.7	6.2	6.8	7.3	7.9	8.5	9.1	9.8	10.4	11.1	11.8	12.5	13.3
91	**96**	**101**	**106**	**111**	**116**	**121**	**126**	**131**	**136**	**141**	**146**	**151**	**156**	**161**	**166**	**171**	**176**
9.5	10.0	10.5	11.0	11.6	12.1	12.6	13.1	13.7	14.2	14.7	15.2	15.8	16.3	16.8	17.3	17.9	18.4
10.0	9.5	9.0	8.6	8.2	7.8	7.5	7.2	6.9	6.7	6.4	6.2	6.0	5.8	5.6	5.5	5.3	5.1
0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0
4.5	5.0	5.6	6.1	6.7	7.4	8.0	8.7	9.4	10.2	10.9	11.7	12.6	13.4	14.3	15.2	16.1	17.1
91	**96**	**101**	**106**	**111**	**116**	**121**	**126**	**131**	**136**	**141**	**146**	**151**	**156**	**161**	**166**	**171**	**176**
11.0	11.7	12.3	12.9	13.5	14.1	14.7	15.3	16.0	16.6	17.2	17.8	18.4	19.0	19.6	20.2	20.9	21.5
7.4	7.0	6.7	6.4	6.1	5.8	5.6	5.3	5.1	4.9	4.8	4.6	4.5	4.3	4.2	4.0	3.9	3.8
0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.2	1.2	1.2	1.3	1.3
6.1	6.8	7.5	8.3	9.1	9.9	10.8	11.7	12.7	13.7	14.7	15.8	16.9	18.1	19.3	20.5	21.8	23.1
91	**96**	**101**	**106**	**111**	**116**	**121**	**126**	**131**	**136**	**141**	**147**	**152**	**157**	**162**	**167**	**172**	**177**
12.6	13.3	14.0	14.7	15.5	16.2	16.9	17.6	18.3	19.0	19.7	20.4	21.1	21.8	22.5	23.2	23.9	24.6
5.3	5.0	4.7	4.5	4.3	4.1	3.9	3.8	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7
0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8
8.6	9.6	10.6	11.7	12.8	14.0	15.3	16.6	18.0	19.4	20.9	22.4	24.0	25.6	27.3	29.0	30.8	32.6
91	**96**	**101**	**106**	**111**	**117**	**122**	**127**	**132**	**137**	**142**	**147**	**152**	**157**	**162**	**167**	**172**	**177**
14.2	15.0	15.8	16.6	17.4	18.2	19.0	19.8	20.6	21.4	22.2	23.0	23.7	24.5	25.3	26.1	26.9	27.7
3.5	3.4	3.2	3.0	2.9	2.8	2.7	2.5	2.5	2.4	2.3	2.2	2.1	2.1	2.0	1.9	1.9	1.8
1.4	1.5	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.7	2.7
12.7	14.2	15.7	17.4	19.1	20.9	22.7	24.7	26.7	28.8	31.0	33.3	35.6	38.0	40.5	43.1	45.8	48.5
91	**97**	**102**	**107**	**112**	**117**	**122**	**127**	**132**	**137**	**142**	**147**	**152**	**158**	**163**	**168**	**173**	**178**
15.9	16.7	17.6	18.5	19.4	20.3	21.1	22.0	22.9	23.8	24.7	25.6	26.4	27.3	28.2	29.1	30.0	30.8
2.3	2.2	2.0	1.9	1.9	1.8	1.7	1.6	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2
2.2	2.3	2.4	2.5	2.7	2.8	2.9	3.0	3.2	3.3	3.4	3.5	3.7	3.8	3.9	4.0	4.2	4.3
20.0	22.3	24.7	27.2	29.9	32.7	35.6	38.7	41.8	45.1	48.5	52.1	55.8	59.5	63.5	67.5	71.7	75.9

Inlet			Outlet at 175m															
			angle (deg)=	0.0			1.0			2.0			3.0			4.0			
			r(m)=	0.0			3.1			6.1			9.2			12.2			
			1/2 A(m^2)=	0.1			14.6			43.8			73.4			102.9			
			us(m/min)=	11.6			11.4			10.8			9.5			8.1			
			ts(min)=	7.5			7.7			8.2			9.2			10.8			
T inlet	C/Co	Toutlet	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co
17	0.00	25	0.00	25	0.00	0.00	25	0.00	0.00	25	0.00							
18	0.00	26	0.00	26	0.00	0.00	26	0.00	0.00	26	0.00	0.00	26	0.00				
19	0.00	27	0.00	27	0.00	0.00	27	0.00	0.00	27	0.00	0.00	27	0.00				
20	0.00	28	0.00	28	0.00	0.00	28	0.00	0.00	28	0.00	0.00	28	0.00	0.00	28	0.00	
21	0.00	29	0.00	29	0.00	0.00	29	0.00	0.00	29	0.00	0.00	29	0.00	0.00	29	0.00	
22	0.05	30	0.00	30	0.00	0.00	30	0.25	0.00	30	0.89	0.00	30	0.51	0.00	30	0.00	0.00
23	0.15	31	0.00	31	0.00	0.00	31	0.74	0.00	31	2.06	0.00	31	1.99	0.00	31	0.57	0.00
24	0.28	32	0.00	32	0.01	32	1.29	0.01	32	3.57	0.00	32	4.04	0.00	32	1.71	0.00	
25	0.36	33	0.00	33	0.01	33	1.78	0.01	33	4.94	0.01	33	6.06	0.00	33	3.46	0.00	
26	0.50	34	0.00	34	0.01	34	2.47	0.01	34	6.86	0.01	34	8.43	0.00	34	5.80	0.00	
27	0.62	35	0.01	35	0.02	35	3.07	0.02	35	8.50	0.01	35	10.96	0.01	35	8.29	0.00	
28	0.72	36	0.01	36	0.02	36	3.56	0.02	36	9.87	0.02	36	13.08	0.01	36	10.66	0.00	
29	0.80	37	0.01	37	0.02	37	3.96	0.02	37	10.97	0.02	37	14.82	0.01	37	13.20	0.00	
30	0.86	38	0.01	38	0.03	38	4.25	0.02	38	11.79	0.02	38	16.18	0.01	38	15.31	0.01	
31	0.88	39	0.01	39	0.03	39	4.35	0.02	39	12.07	0.02	39	16.94	0.02	39	16.99	0.01	
32	0.90	40	0.01	40	0.03	40	4.45	0.02	40	12.34	0.02	40	17.33	0.02	40	18.02	0.01	
33	0.92	41	0.01	41	0.03	41	4.55	0.03	41	12.62	0.02	41	17.71	0.02	41	18.85	0.01	
34	0.94	42	0.01	42	0.03	42	4.65	0.03	42	12.89	0.02	42	18.10	0.02	42	19.27	0.01	
35	0.95	43	0.01	43	0.03	43	4.70	0.03	43	13.03	0.02	43	18.39	0.02	43	19.70	0.02	
36	0.95	44	0.01	44	0.03	44	4.70	0.03	44	13.03	0.02	44	18.48	0.02	44	20.02	0.02	
37	0.96	45	0.01	45	0.03	45	4.75	0.03	45	13.17	0.02	45	18.59	0.02	45	20.22	0.02	
38	0.96	46	0.01	46	0.03	46	4.75	0.03	46	13.17	0.02	46	18.68	0.02	46	20.43	0.02	
39	0.96	47	0.01	47	0.03	47	4.75	0.03	47	13.17	0.02	47	18.68	0.02	47	20.43	0.02	
40	0.96	48	0.01	48	0.03	48	4.75	0.03	48	13.17	0.02	48	18.68	0.02	48	20.53	0.02	
41	0.96	49	0.01	49	0.03	49	4.75	0.03	49	13.17	0.02	49	18.68	0.02	49	20.53	0.02	
42	0.97	50	0.01	50	0.03	50	4.80	0.03	50	13.30	0.02	50	18.78	0.02	50	20.53	0.02	
43	0.97	51	0.01	51	0.03	51	4.80	0.03	51	13.30	0.02	51	18.87	0.02	51	20.64	0.02	
44	0.98	52	0.01	52	0.03	52	4.85	0.03	52	13.44	0.02	52	18.96	0.02	52	20.64	0.02	
45	0.98	53	0.01	53	0.03	53	4.85	0.03	53	13.44	0.02	53	19.07	0.02	53	20.86	0.02	
46	0.99	54	0.01	54	0.03	54	4.90	0.03	54	13.58	0.02	54	19.17	0.02	54	20.86	0.02	
47	0.99	55	0.01	55	0.03	55	4.90	0.03	55	13.58	0.02	55	19.26	0.02	55	21.07	0.02	
48	0.99	56	0.01	56	0.03	56	4.90	0.03	56	13.58	0.02	56	19.26	0.02	56	21.07	0.02	
49	1.00	57	0.01	57	0.03	57	4.95	0.03	57	13.71	0.02	57	19.36	0.02	57	21.17	0.02	
50	1.00	58	0.01	58	0.03	58	4.95	0.03	58	13.71	0.03	58	19.46	0.02	58	21.28	0.02	
51	1.00	59	0.01	59	0.03	59	4.95	0.03	59	13.71	0.03	59	19.46	0.02	59	21.28	0.02	
52	1.00	60	0.01	60	0.03	60	4.95	0.03	60	13.71	0.03	60	19.46	0.02	60	21.38	0.02	
53	1.00	61	0.01	61	0.03	61	4.95	0.03	61	13.71	0.03	61	19.46	0.02	61	21.38	0.02	
END		62	0.01		0.03		4.95	0.03		13.73	0.03	62	19.46	0.02	62	21.38	0.02	
		63	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02	63	21.38	0.02	
		64	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02	64	21.38	0.02	
		65	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		66	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		67	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		68	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		69	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		70	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		71	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		72	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		73	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		74	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		75	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		76	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		77	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		78	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		79	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		80	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		81	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		82	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		83	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		84	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		85	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		86	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		87	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		88	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		89	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		90	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		91	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		92	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		93	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		94	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		95	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		96	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		97	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	
		98	0.01		0.03		4.95	0.03		13.73	0.03		19.46	0.02		21.38	0.02	

99	0.03	0.01	0.03	4.95	0.03	13.73	0.03	19.46	0.02	21.38	0.02
100	0.03	0.01	0.03	4.95	0.03	13.73	0.03	19.46	0.02	21.38	0.02
101	0.03	0.01	0.03	4.95	0.03	13.73	0.03	19.46	0.02	21.38	0.02
102	0.03	0.01	0.03	4.95	0.03	13.73	0.03	19.46	0.02	21.38	0.02
103	0.03	0.01	0.03	4.95	0.03	13.73	0.03	19.46	0.02	21.38	0.02

5.0		6.0			7.0			8.0			9.0			10.0			Complete		Jet Core (2")	
15.3		18.4			21.5			24.6			27.7			30.8			Total Flux		Total Flux	
132.8		183.0			193.5			224.6			256.2			288.5						
6.6		5.1			3.8			2.7			1.8			1.2						
13.3		17.1			23.1			32.6			48.5			78.9						
Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Mass	C/Co	Mass
																	0.00	0.0	0.00	0.0
																	0.00	0.0	0.00	0.0
																	0.00	0.0	0.00	0.0
																	0.00	0.0	0.00	0.0
																	0.00	0.0	0.00	0.0
30	0.00																0.01	1.4	0.01	0.9
31	0.00																0.04	5.4	0.02	2.8
32	0.00																0.09	10.8	0.04	4.9
33	0.54																0.14	16.8	0.05	6.7
34	1.62	0.00	34	0.00													0.20	25.0	0.06	9.3
35	3.26	0.00	35	0.45													0.28	34.5	0.09	11.6
36	5.25	0.00	36	1.34													0.35	43.6	0.11	13.4
37	7.76	0.00	37	2.32													0.43	53.0	0.12	14.9
38	9.96	0.00	38	3.22													0.49	60.7	0.13	16.1
39	12.32	0.00	39	4.83													0.54	67.5	0.13	16.4
40	14.27	0.00	40	6.83	0.00	40	0.99										0.60	74.0	0.14	16.8
41	15.83	0.00	41	8.32	0.00	41	1.71										0.64	79.6	0.14	17.2
42	16.78	0.01	42	9.76	0.00	42	2.37										0.67	83.8	0.14	17.5
43	17.54	0.01	43	11.32	0.00	43	3.29										0.71	88.0	0.14	17.7
44	17.94	0.01	44	12.37	0.00	44	4.06										0.73	90.6	0.14	17.7
45	18.34	0.01	45	13.27	0.00	45	5.00										0.75	93.3	0.14	17.9
46	18.63	0.01	46	14.03	0.00	46	6.04										0.77	95.7	0.14	17.9
47	18.81	0.01	47	14.65	0.00	47	7.00										0.78	97.5	0.14	17.9
48	19.01	0.01	48	14.88	0.00	48	7.85										0.79	98.7	0.14	17.9
49	19.01	0.01	49	15.03	0.01	49	8.50										0.80	99.7	0.14	17.9
50	19.10	0.01	50	15.26	0.01	50	9.25	0.00	50	2.70							0.83	103.7	0.15	18.1
51	19.10	0.01	51	15.41	0.01	51	9.90	0.00	51	3.13							0.85	105.2	0.15	18.1
52	19.10	0.01	52	15.48	0.01	52	10.38	0.00	52	3.48							0.86	106.4	0.15	18.3
53	19.21	0.01	53	15.48	0.01	53	10.69	0.00	53	3.74							0.86	107.3	0.15	18.3
54	19.21	0.01	54	15.55	0.01	54	10.86	0.00	54	3.83							0.87	108.0	0.15	18.5
55	19.41	0.01	55	15.64	0.01	55	10.96	0.00	55	4.08							0.88	108.9	0.15	18.5
56	19.41	0.01	56	15.64	0.01	56	11.06	0.00	56	4.50							0.88	109.4	0.15	18.5
57	19.60	0.01	57	15.73	0.01	57	11.17	0.00	57	4.94							0.89	110.7	0.15	18.7
58	19.60	0.01	58	15.73	0.01	58	11.22	0.00	58	5.32							0.90	111.3	0.15	18.7
59	19.70	0.01	59	15.90	0.01	59	11.28	0.00	59	5.78							0.90	112.1	0.15	18.7
60	19.80	0.01	60	15.90	0.01	60	11.34	0.01	60	6.21							0.91	112.8	0.15	18.7
61	19.80	0.01	61	15.97	0.01	61	11.40	0.01	61	6.54							0.91	113.2	0.15	18.7
62	19.89	0.01	62	16.06	0.01	62	11.40	0.01	62	6.80							0.91	113.7	0.15	18.7
63	19.89	0.02	63	16.13	0.01	63	11.47	0.01	63	7.00							0.92	114.0	0.15	18.7
64	19.89	0.02	64	16.13	0.01	64	11.47	0.01	64	7.06							0.92	114.1	0.15	18.7
65	19.89	0.02	65	16.13	0.01	65	11.52	0.01	65	7.17							0.92	114.2	0.15	18.7
66	19.89	0.02	66	16.20	0.01	66	11.59	0.01	66	7.24	0.00	66	2.39				0.94	116.8	0.15	18.7
	19.89	0.02	67	16.20	0.01	67	11.64	0.01	67	7.35	0.00	67	2.44				0.94	117.0	0.15	18.7
	19.89	0.02	68	16.20	0.01	68	11.64	0.01	68	7.38	0.00	68	2.46				0.94	117.1	0.15	18.7
	19.89	0.02	69	16.20	0.01	69	11.69	0.01	69	7.42	0.00	69	2.48				0.94	117.2	0.15	18.7
	19.89	0.02	70	16.20	0.01	70	11.69	0.01	70	7.46	0.00	70	2.49				0.94	117.3	0.15	18.7
	19.89	0.02		16.20	0.01	71	11.69	0.01	71	7.46	0.00	71	2.58				0.94	117.4	0.15	18.7
	19.89	0.02		16.20	0.01	72	11.74	0.01	72	7.50	0.00	72	2.77				0.95	117.6	0.15	18.7
	19.89	0.02		16.20	0.01	73	11.74	0.01	73	7.50	0.00	73	2.96				0.95	117.8	0.15	18.7
	19.89	0.02		16.20	0.01	74	11.74	0.01	74	7.50	0.00	74	3.17				0.95	118.0	0.15	18.7
	19.89	0.02		16.20	0.01	75	11.74	0.01	75	7.53	0.00	75	3.46				0.95	118.4	0.15	18.7
	19.89	0.02		16.20	0.01	76	11.74	0.01	76	7.53	0.00	76	3.68				0.95	118.6	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01	77	7.57	0.00	77	3.89				0.96	118.8	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01	78	7.57	0.01	78	4.04				0.96	119.0	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01	79	7.60	0.01	79	4.18				0.96	119.1	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01	80	7.60	0.01	80	4.22				0.96	119.2	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01	81	7.60	0.01	81	4.26				0.96	119.2	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01	82	7.63	0.01	82	4.32				0.96	119.3	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01	83	7.63	0.01	83	4.36				0.96	119.4	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01	84	7.63	0.01	84	4.38				0.96	119.4	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01	85	7.63	0.01	85	4.38				0.96	119.4	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01	86	7.63	0.01	86	4.40				0.96	119.4	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	87	4.40				0.96	119.4	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	88	4.40				0.96	119.4	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	89	4.40				0.96	119.4	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	90	4.40				0.96	119.4	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	91	4.42				0.96	119.4	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	92	4.42				0.96	119.4	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	93	4.43	0.00	93	1.37	0.97	120.8	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	94	4.43	0.00	94	1.37	0.97	120.8	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	95	4.45	0.00	95	1.38	0.97	120.8	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	96	4.45	0.00	96	1.38	0.97	120.8	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	97	4.45	0.00	97	1.38	0.97	120.8	0.15	18.7
	19.89	0.02		16.20	0.01		11.74	0.01		7.63	0.01	98	4.47	0.00	98	1.45	0.97	120.9	0.15	18.7

19.89	0.02	16.20	0.01	11.74	0.01	7.63	0.01	99	4.47	0.00	99	1.54	0.97	121.0	0.15	18.7
19.89	0.02	16.20	0.01	11.74	0.01	7.63	0.01	100	4.47	0.00	100	1.65	0.97	121.1	0.15	18.7
19.89	0.02	16.70	0.01	11.74	0.01	7.63	0.01	101	4.47	0.00	101	1.75	0.98	121.2	0.15	18.7
19.89	0.02	16.20	0.01	11.74	0.01	7.63	0.01	102	4.47	0.00	102	1.86	0.98	121.4	0.15	18.7
19.89	0.02	16.20	0.01	11.74	0.01	7.63	0.01		4.47	0.00	103	2.00	0.98	121.5	0.15	18.7

RESERVOIR NO. 3 (198 ML/d) - JET MODEL

vol. of tank	43762	m3
qo(initial flow)	137.50	m3/min
do(imaginary pipe diam)	1.20	m
Ao(m^2)	1.13	m^2
uo(initial velocity)	121.64	m/min

JETS

x1 (core length) = 18*ro	10.80	m
imaginary plane=	175	m
water level=	4.2	m
angle for jet core =	2	°

ux = 9* (do/x)*uo *exp(-74 * (r/x)^2)

Cx =Co*7* (do/x) * exp(-64* (r/x)^2)

		x (m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
angle (deg)	0.0	x'(m)=	0.0	10.0	15.0	20.0	25.0	30.0	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		ux(m/min)=	121.6	121.6	97.6	65.7	52.5	43.8	37.5	32.8	29.2	26.3	23.9	21.9	20.2	18.8	17.5	16.4	15.5
		dt x(min)=	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.2	1.4	1.6	1.9	2.2	2.5	2.8
	1.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.3	1.4	1.5
		ux(m/min)=	121.6	121.6	85.6	64.2	51.4	42.8	36.7	32.1	28.5	25.7	23.4	21.4	19.8	18.3	17.1	16.1	15.1
		dt x(min)=	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.2	1.4	1.7	1.9	2.2	2.5	2.8
	2.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.3	0.5	0.7	0.9	1.0	1.2	1.4	1.6	1.7	1.9	2.1	2.3	2.4	2.6	2.8	3.0
		ux(m/min)=	121.6	121.6	80.0	60.0	48.0	40.0	34.3	30.0	26.7	24.0	21.8	20.0	18.5	17.1	16.0	15.0	14.1
		dt x(min)=	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.8	2.1	2.4	2.7	3.0
	3.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.4	2.6	2.9	3.1	3.4	3.7	3.9	4.2	4.5
		ux(m/min)=	121.6	121.6	71.5	53.6	42.9	35.7	30.6	26.8	23.8	21.4	19.5	17.9	16.5	15.3	14.3	13.4	12.6
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4
		tx(min)=	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.2	1.4	1.7	2.0	2.3	2.6	3.0	3.4
	4.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.1	3.5	3.8	4.2	4.5	4.9	5.2	5.6	5.9
		ux(m/min)=	121.6	121.6	61.0	45.8	36.6	30.5	26.1	22.9	20.3	18.3	16.6	15.3	14.1	13.1	12.2	11.4	10.8
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
		tx(min)=	0.0	0.1	0.1	0.2	0.4	0.5	0.7	0.9	1.1	1.4	1.7	2.0	2.3	2.7	3.1	3.5	4.0
	5.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	0.9	1.3	1.7	2.2	2.6	3.1	3.5	3.9	4.4	4.8	5.2	5.7	6.1	6.6	7.0	7.4
		ux(m/min)=	121.6	121.6	49.7	37.3	29.8	24.9	21.3	18.7	16.6	14.9	13.6	12.4	11.5	10.7	9.9	9.3	8.8
		dt x(min)=	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6
		tx(min)=	0.0	0.1	0.1	0.3	0.4	0.6	0.8	1.1	1.3	1.7	2.0	2.4	2.8	3.3	3.8	4.3	4.8
	6.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
		r(m)=	0.0	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.7	5.3	5.8	6.3	6.8	7.4	7.9	8.4	8.9
		ux(m/min)=	121.6	121.6	38.7	29.0	23.2	19.4	16.6	14.5	12.9	11.6	10.6	9.7	8.9	8.3	7.7	7.3	6.8
		dt x(min)=	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.7	0.7
		tx(min)=	0.0	0.1	0.1	0.3	0.5	0.7	1.0	1.3	1.7	2.1	2.6	3.1	3.6	4.2	4.8	5.5	6.2
	7.0	x'(m)=	0	10	15	20	25	30	35	40	45	50	55	60	66	71	76	81	86
		r(m)=	0.0	1.2	1.8	2.5	3.1	3.7	4.3	4.9	5.5	6.1	6.7	7.4	8.0	8.6	9.2	9.8	10.4
		ux(m/min)=	121.6	121.6	28.7	21.6	17.2	14.4	12.3	10.8	9.6	8.6	7.8	7.2	6.6	6.2	5.7	5.4	5.1
		dt x(min)=	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	1.0
		tx(min)=	0.0	0.1	0.1	0.4	0.6	0.9	1.3	1.7	2.2	2.8	3.4	4.1	4.8	5.6	6.4	7.3	8.3
	8.0	x'(m)=	0	10	15	20	25	30	35	40	45	51	56	61	66	71	76	81	86
		r(m)=	0.0	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0	7.7	8.4	9.1	9.8	10.5	11.2	11.9
		ux(m/min)=	121.6	121.6	20.3	15.3	12.2	10.2	8.7	7.6	6.8	6.1	5.5	5.1	4.7	4.4	4.1	3.8	3.6
		dt x(min)=	0.0	0.1	0.1	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.2	1.3	1.4
		tx(min)=	0.0	0.1	0.2	0.4	0.8	1.3	1.8	2.4	3.1	3.9	4.8	5.7	6.7	7.9	9.1	10.3	11.7
	9.0	x'(m)=	0	10	15	20	25	30	35	41	46	51	56	61	66	71	76	81	86
		r(m)=	0.0	1.6	2.4	3.2	4.0	4.7	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.1	11.9	12.7	13.5
		ux(m/min)=	121.6	121.6	13.7	10.3	8.2	6.9	5.9	5.1	4.6	4.1	3.7	3.4	3.2	2.9	2.7	2.6	2.4
		dt x(min)=	0.0	0.1	0.1	0.4	0.5	0.7	0.8	0.9	1.0	1.2	1.3	1.4	1.5	1.7	1.8	1.9	2.0
		tx(min)=	0.0	0.1	0.2	0.6	1.1	1.8	2.6	3.5	4.6	5.7	7.0	8.4	10.0	11.6	13.4	15.3	17.3
	10.0	x'(m)=	0	10	15	20	25	30	36	41	46	51	56	61	66	71	76	81	86
		r(m)=	0.0	1.8	2.6	3.5	4.4	5.3	6.2	7.0	7.9	8.8	9.7	10.6	11.5	12.3	13.2	14.1	15.0
		ux(m/min)=	121.6	121.6	8.8	6.6	5.3	4.4	3.8	3.3	2.9	2.6	2.4	2.2	2.0	1.9	1.8	1.6	1.6
		dt x(min)=	0.0	0.1	0.1	0.7	0.9	1.1	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
		tx(min)=	0.0	0.1	0.2	0.8	1.7	2.7	4.0	5.4	7.0	8.9	10.9	13.1	15.5	18.1	20.9	23.9	27.0

90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175
90	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.6	13.8	13.1	12.5	11.9	11.4	10.9	10.5	10.1	9.7	9.4	9.1	8.8	8.5	8.2	8.0	7.7	7.5
0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7
3.1	3.5	3.8	4.2	4.6	5.1	5.5	6.0	6.5	7.0	7.5	8.0	8.6	9.2	9.8	10.4	11.0	11.7
90	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**
1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1
14.3	13.5	12.8	12.2	11.7	11.2	10.7	10.3	9.9	9.5	9.2	8.9	8.6	8.3	8.0	7.8	7.6	7.3
0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7
3.2	3.5	3.9	4.3	4.7	5.2	5.6	6.1	6.6	7.1	7.7	8.2	8.8	9.4	10.0	10.6	11.3	12.0
90	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**
3.1	3.3	3.5	3.7	3.8	4.0	4.2	4.4	4.5	4.7	4.9	5.1	5.2	5.4	5.6	5.8	5.9	6.1
13.3	12.6	12.0	11.4	10.9	10.4	10.0	9.6	9.2	8.9	8.6	8.3	8.0	7.7	7.5	7.3	7.1	6.9
0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7
3.4	3.8	4.2	4.6	5.1	5.5	6.0	6.5	7.1	7.6	8.2	8.8	9.4	10.0	10.7	11.4	12.1	12.8
90	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**
4.7	5.0	5.2	5.5	5.8	6.0	6.3	6.5	6.8	7.1	7.3	7.6	7.9	8.1	8.4	8.6	8.9	9.2
11.9	11.3	10.7	10.2	9.7	9.3	8.9	8.6	8.2	7.9	7.7	7.4	7.1	6.9	6.7	6.5	6.3	6.1
0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8
3.8	4.2	4.7	5.2	5.7	6.2	6.7	7.3	7.9	8.5	9.2	9.8	10.5	11.2	12.0	12.7	13.5	14.3
90	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**	**155**	**160**	**165**	**170**	**175**
6.3	6.6	7.0	7.3	7.7	8.0	8.4	8.7	9.1	9.4	9.8	10.1	10.5	10.8	11.2	11.5	11.9	12.2
10.2	9.6	9.2	8.7	8.3	8.0	7.6	7.3	7.0	6.8	6.5	6.3	6.1	5.9	5.7	5.5	5.4	5.2
0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9
4.4	4.9	5.5	6.0	6.6	7.2	7.9	8.6	9.3	10.0	10.7	11.5	12.3	13.2	14.0	14.9	15.8	16.8
90	**95**	**100**	**105**	**110**	**115**	**120**	**126**	**131**	**136**	**141**	**146**	**151**	**156**	**161**	**166**	**171**	**176**
7.9	8.3	8.7	9.2	9.6	10.1	10.5	10.9	11.4	11.8	12.2	12.7	13.1	13.6	14.0	14.4	14.9	15.3
8.3	7.9	7.5	7.1	6.8	6.5	6.2	6.0	5.7	5.5	5.3	5.1	5.0	4.8	4.7	4.5	4.4	4.3
0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.2
5.4	6.0	6.7	7.4	8.1	8.9	9.7	10.5	11.3	12.2	13.2	14.1	15.1	16.1	17.2	18.3	19.4	20.6
91	**96**	**101**	**106**	**111**	**116**	**121**	**126**	**131**	**136**	**141**	**146**	**151**	**156**	**161**	**166**	**171**	**176**
9.5	10.0	10.5	11.0	11.6	12.1	12.6	13.1	13.7	14.2	14.7	15.2	15.8	16.3	16.8	17.3	17.9	18.4
6.5	6.1	5.8	5.5	5.3	5.0	4.8	4.6	4.5	4.3	4.1	4.0	3.9	3.7	3.6	3.5	3.4	3.3
0.8	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5
6.9	7.7	8.6	9.5	10.4	11.4	12.4	13.5	14.6	15.7	16.9	18.1	19.4	20.7	22.1	23.5	25.0	26.5
91	**96**	**101**	**106**	**111**	**116**	**121**	**126**	**131**	**136**	**141**	**146**	**151**	**156**	**161**	**166**	**171**	**176**
11.0	11.7	12.3	12.9	13.5	14.1	14.7	15.3	16.0	16.6	17.2	17.8	18.4	19.0	19.6	20.2	20.9	21.5
4.8	4.5	4.3	4.1	3.9	3.7	3.6	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.5
1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.8	1.9	2.0	2.0
9.3	10.4	11.6	12.8	14.0	15.3	16.7	18.1	19.6	21.2	22.8	24.4	26.2	27.9	29.8	31.7	33.6	35.7
91	**96**	**101**	**106**	**111**	**116**	**121**	**126**	**131**	**136**	**141**	**147**	**152**	**157**	**162**	**167**	**172**	**177**
12.6	13.3	14.0	14.7	15.5	16.2	16.9	17.6	18.3	19.0	19.7	20.4	21.1	21.8	22.5	23.2	23.9	24.6
3.4	3.2	3.1	2.9	2.8	2.7	2.5	2.4	2.3	2.3	2.2	2.1	2.0	2.0	1.9	1.8	1.8	1.7
1.4	1.5	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.4	2.5	2.6	2.7	2.8	2.9
13.2	14.7	16.3	18.0	19.8	21.6	23.6	25.6	27.7	29.9	32.2	34.6	37.0	39.5	42.1	44.8	47.6	50.5
91	**96**	**101**	**106**	**111**	**117**	**122**	**127**	**132**	**137**	**142**	**147**	**152**	**157**	**162**	**167**	**172**	**177**
14.2	15.0	15.8	16.6	17.4	18.2	19.0	19.8	20.6	21.4	22.2	23.0	23.7	24.5	25.3	26.1	26.9	27.7
2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2
2.2	2.3	2.4	2.5	2.6	2.8	2.9	3.0	3.1	3.3	3.4	3.5	3.6	3.8	3.9	4.0	4.1	4.2
19.5	21.8	24.2	26.7	29.4	32.1	35.0	38.0	41.2	44.4	47.8	51.3	55.0	58.7	62.6	66.6	70.7	75.0
91	**97**	**102**	**107**	**112**	**117**	**122**	**127**	**132**	**137**	**142**	**147**	**152**	**158**	**163**	**168**	**173**	**178**
15.9	16.7	17.6	18.5	19.4	20.3	21.1	22.0	22.9	23.8	24.7	25.6	26.4	27.3	28.2	29.1	30.0	30.8
1.5	1.4	1.3	1.3	1.2	1.1	1.1	1.1	1.0	1.0	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8
3.4	3.6	3.8	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.5	5.7	5.9	6.1	6.3	6.5	6.6
30.4	34.0	37.7	41.7	45.8	50.1	54.7	59.4	64.3	69.4	74.7	80.2	85.9	91.7	97.8	104.1	110.5	117.2

Inlet			Outlet at 175m																
			angle (deg)=	0.0			1.0			2.0			3.0			4.0			
			r(m)=	0.0			3.1			6.1			9.2			12.2			
			1/2 A(m^2)=	0.1			14.6			43.9			73.4			102.9			
			us(m/min)=	7.5			7.3			6.9			6.1			5.2			
			ts(min)=	11.7			12.0			12.8			14.3			16.8			
T inlet	C/Co	Toutlet		C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co
17	0.03	29		0.00	29	0.00	0.00	29	0.16										
18	0.03	30		0.00	30	0.00	0.00	30	0.17	0.00	30	0.48							
19	0.02	31		0.00	31	0.00	0.00	31	0.11	0.00	31	0.38	0.00	31	0.65				
20	0.02	32		0.00	32	0.00	0.00	32	0.11	0.00	32	0.30	0.00	32	0.53				
21	0.02	33		0.00	33	0.00	0.00	33	0.11	0.00	33	0.30	0.00	33	0.43				
22	0.02	34		0.00	34	0.00	0.00	34	0.11	0.00	34	0.30	0.00	34	0.43	0.00	34	0.58	
23	0.10	35		0.01	35	0.00	0.00	35	0.56	0.00	35	0.93	0.00	35	0.43	0.00	35	0.58	
24	0.25	36		0.01	36	0.00	0.01	36	1.39	0.00	36	2.69	0.00	36	1.33	0.00	36	0.47	
25	0.36	37		0.02	37	0.00	0.02	37	2.00	0.01	37	4.65	0.00	37	3.84	0.00	37	1.48	
26	0.50	38		0.03	38	0.00	0.02	38	2.78	0.02	38	6.55	0.01	38	6.62	0.00	38	3.37	0.00
27	0.67	39		0.04	39	0.01	0.03	39	3.72	0.02	39	8.91	0.02	39	9.32	0.00	39	4.78	0.00
28	0.76	40		0.04	40	0.01	0.04	40	4.22	0.03	40	10.87	0.02	40	12.88	0.00	40	7.40	0.00
29	0.78	41		0.04	41	0.01	0.04	41	4.33	0.04	41	11.66	0.03	41	15.43	0.01	41	11.20	0.00
30	0.85	42		0.04	42	0.01	0.04	42	4.72	0.04	42	12.36	0.03	42	16.58	0.01	42	13.55	0.00
31	0.88	43		0.06	43	0.01	0.04	43	4.89	0.04	43	13.13	0.03	43	17.58	0.02	43	16.35	0.00
32	0.90	44		0.06	44	0.01	0.04	44	5.00	0.04	44	13.50	0.04	44	18.63	0.03	44	18.12	0.00
33	0.86	45		0.06	45	0.01	0.04	45	4.78	0.04	45	13.34	0.04	45	19.16	0.03	45	19.49	0.01
34	0.94	46		0.05	46	0.01	0.05	46	5.22	0.04	46	13.67	0.04	46	18.92	0.03	46	19.96	0.01
35	0.97	47		0.06	47	0.01	0.05	47	5.39	0.04	47	14.49	0.04	47	19.41	0.03	47	20.23	0.02
36	0.96	48		0.05	48	0.01	0.05	48	5.33	0.05	48	14.84	0.04	48	20.57	0.03	48	21.57	0.02
37	0.96	49		0.06	49	0.01	0.05	49	5.33	0.05	49	14.56	0.04	49	20.76	0.03	49	22.17	0.02
38	0.96	50		0.05	50	0.01	0.05	50	5.33	0.05	50	14.56	0.04	50	20.66	0.03	50	21.80	0.02
39	0.95	51		0.05	51	0.01	0.05	51	5.28	0.05	51	14.48	0.04	51	20.86	0.04	51	22.49	0.03
40	0.95	52		0.05	52	0.01	0.05	52	5.28	0.04	52	14.41	0.04	52	20.55	0.04	52	22.82	0.03
41	0.96	53		0.05	53	0.01	0.05	53	5.33	0.04	53	14.49	0.04	53	20.45	0.04	53	22.58	0.03
42	0.97	54		0.05	54	0.01	0.05	54	5.39	0.05	54	14.64	0.04	54	20.56	0.04	54	22.58	0.03
43	0.98	55		0.05	55	0.01	0.05	55	5.45	0.05	55	14.79	0.04	55	20.77	0.04	55	22.71	0.03
44	1.00	56		0.05	56	0.01	0.05	56	5.56	0.05	56	15.02	0.04	56	20.99	0.04	56	22.72	0.03
45	1.00	57		0.05	57	0.01	0.05	57	5.56	0.05	57	15.17	0.04	57	21.32	0.04	57	22.85	0.03
46	1.00	58		0.05	58	0.01	0.05	58	5.56	0.05	58	15.17	0.04	58	21.52	0.04	58	23.21	0.03
47	1.00	59		0.05	59	0.01	0.05	59	5.56	0.05	59	15.17	0.04	59	21.52	0.04	59	23.32	0.03
48	1.00	60		0.05	60	0.01	0.05	60	5.56	0.05	60	15.17	0.04	60	21.52	0.04	60	23.43	0.03
49	1.00	61		0.05	61	0.01	0.05	61	5.56	0.05	61	15.17	0.04	61	21.52	0.04	61	23.65	0.03
50	1.00	62		0.05	62	0.01	0.05	62	5.56	0.05	62	15.17	0.04	62	21.52	0.04	62	23.65	0.03
51	1.00	63		0.05	63	0.01	0.05	63	5.56	0.05	63	15.17	0.04	63	21.52	0.04	63	23.65	0.03
52	1.00	64		0.05	64	0.01	0.05	64	5.56	0.05	64	15.17	0.04	64	21.52	0.04	64	23.65	0.03
53	1.00	65		0.05	65	0.01	0.05	65	5.56	0.05	65	15.17	0.04	65	21.52	0.04	65	23.65	0.03
END		66		0.05		0.01	0.05		5.56	0.05	66	15.17	0.04	66	21.52	0.04	66	23.65	0.03
		67		0.05		0.01	0.05		5.56	0.05		15.17	0.04	67	21.52	0.04	67	23.65	0.03
		68		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04	68	23.65	0.03
		69		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04	69	23.65	0.03
		70		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04	70	23.65	0.03
		71		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		72		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		73		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		74		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		75		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		76		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		77		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		78		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		79		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		80		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		81		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		82		0.06		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		83		0.06		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		84		0.06		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		85		0.06		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		86		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		87		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		88		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		89		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		90		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		91		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		92		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		93		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		94		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		95		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		96		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		97		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		98		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		99		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		100		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		101		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03
		102		0.05		0.01	0.05		5.56	0.05		15.17	0.04		21.52	0.04		23.65	0.03

103	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
104	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
105	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
106	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
107	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
108	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
109	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
110	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
111	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
112	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
113	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
114	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
115	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
116	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
117	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
118	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
119	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
120	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
121	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
122	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
123	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
124	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
125	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
126	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
127	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
128	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
129	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
130	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
131	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
132	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
133	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
134	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
135	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
136	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
137	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
138	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
139	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
140	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
141	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
142	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
143	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03
144	0.06	0.01	0.06	5.56	0.06	15.17	0.04	21.52	0.04	23.65	0.03

5.0		6.0			7.0			8.0			9.0			10.0						
15.3		18.4			21.5			24.6			27.7			30.8						
132.8		183.0			193.5			224.6			256.2			288.5			Complete		Jet Core (2")	
4.3		3.3			2.8			1.7			1.2			0.8			Total Flux		Total Flux	
20.6		26.5			35.7			50.5			75.0			117.2						
Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Tout	Mass	C/Co	Mass	C/Co	Mass
																	0.00	0.2	0.00	0.2
																	0.00	0.6	0.00	0.6
																	0.01	1.1	0.00	0.5
																	0.01	0.9	0.00	0.4
																	0.01	0.8	0.00	0.4
																	0.01	1.4	0.00	0.4
																	0.02	2.5	0.01	1.5
																	0.04	5.9	0.03	4.1
																	0.09	12.0	0.05	8.7
38	0.54																0.14	19.9	0.07	9.3
39	0.54																0.20	27.3	0.09	12.6
40	1.39																0.27	38.6	0.11	15.1
41	3.18																0.33	45.8	0.12	16.0
42	4.49																0.38	51.7	0.12	17.1
43	6.16	0.00	43	0.44													0.42	57.6	0.13	18.0
44	9.00	0.00	44	1.23													0.48	65.5	0.13	18.5
45	11.58	0.00	45	2.63													0.52	71.0	0.13	18.1
46	12.93	0.00	46	3.72													0.54	74.4	0.14	18.9
47	15.18	0.00	47	5.10													0.58	79.8	0.14	19.9
48	17.25	0.00	48	6.78													0.63	86.1	0.15	20.0
49	18.39	0.00	49	8.31													0.65	89.5	0.14	19.9
50	18.12	0.01	50	9.72													0.65	90.0	0.14	19.9
51	19.78	0.01	51	11.29													0.68	94.0	0.14	19.8
52	20.44	0.01	52	12.72													0.70	96.2	0.14	19.7
53	20.52	0.02	53	14.28	0.00	53	5.05										0.75	102.7	0.14	19.8
54	20.12	0.02	54	14.61	0.00	54	5.71										0.75	103.6	0.15	20.0
55	20.92	0.02	55	15.56	0.00	55	5.79										0.77	106.0	0.15	20.2
56	21.11	0.02	56	16.42	0.00	56	6.30										0.79	108.1	0.15	20.6
57	21.01	0.02	57	16.56	0.00	57	6.52										0.79	109.0	0.15	20.7
58	21.13	0.02	58	16.72	0.00	58	6.67										0.80	110.0	0.15	20.7
59	21.24	0.02	59	16.40	0.00	59	6.83										0.80	110.1	0.15	20.7
60	21.26	0.02	60	16.95	0.01	60	8.27										0.82	112.2	0.15	20.7
61	21.50	0.03	61	17.19	0.01	61	9.12										0.83	113.7	0.15	20.7
62	21.60	0.02	62	17.21	0.01	62	9.84										0.83	114.6	0.15	20.7
63	21.70	0.02	63	17.30	0.01	63	10.81										0.84	115.7	0.15	20.7
64	21.80	0.02	64	17.40	0.02	64	11.33										0.85	116.4	0.15	20.7
65	22.01	0.02	65	17.52	0.02	65	11.37										0.85	116.8	0.15	20.7
66	22.01	0.02	66	17.52	0.02	66	11.77										0.85	117.2	0.15	20.7
67	22.01	0.02	67	17.60	0.02	67	12.01	0.00	67	4.35							0.89	121.9	0.15	20.7
68	22.01	0.03	68	17.66	0.02	68	12.20	0.00	68	4.44							0.89	122.2	0.15	20.7
69	22.01	0.03	69	17.76	0.02	69	12.04	0.00	69	4.21							0.89	121.9	0.15	20.7
70	22.01	0.03	70	17.92	0.02	70	12.64	0.00	70	4.60							0.90	123.1	0.15	20.7
71	22.01	0.03	71	17.92	0.02	71	12.81	0.00	71	4.74							0.90	123.4	0.15	20.7
72	22.01	0.03	72	17.92	0.02	72	12.76	0.00	72	4.70							0.90	123.3	0.15	20.7
73	22.01	0.03	73	17.92	0.02	73	12.76	0.00	73	4.99							0.90	123.6	0.15	20.7
74	22.01	0.03	74	17.92	0.02	74	12.76	0.00	74	5.53							0.90	124.1	0.15	20.7
	22.01	0.03	75	17.92	0.02	75	12.70	0.01	75	5.88							0.90	124.4	0.15	20.7
	22.01	0.03	76	17.92	0.02	76	12.70	0.01	76	6.39							0.91	124.9	0.15	20.7
	22.01	0.03	77	17.92	0.02	77	12.76	0.01	77	7.05							0.91	125.7	0.15	20.7
	22.01	0.03	78	17.92	0.02	78	12.81	0.01	78	7.43							0.92	126.1	0.15	20.7
	22.01	0.03	79	17.92	0.02	79	12.87	0.01	79	7.55							0.92	126.3	0.16	20.7
	22.01	0.03		17.92	0.02	80	12.99	0.01	80	7.90							0.92	126.7	0.16	20.7
	22.01	0.03		17.92	0.02	81	12.99	0.01	81	8.01							0.92	126.8	0.16	20.7
	22.01	0.03		17.92	0.02	82	12.99	0.01	82	8.08							0.92	126.9	0.15	20.7
	22.01	0.03		17.92	0.02	83	12.99	0.01	83	7.93							0.92	126.8	0.15	20.7
	22.01	0.03		17.92	0.02	84	12.99	0.01	84	8.22							0.92	127.1	0.16	20.7
	22.01	0.03		17.92	0.02	85	12.99	0.01	85	8.33							0.92	127.2	0.16	20.7
	22.01	0.03		17.92	0.02	86	12.99	0.01	86	8.30							0.92	127.1	0.16	20.7
	22.01	0.03		17.92	0.02	87	12.99	0.01	87	8.30							0.92	127.1	0.16	20.7
	22.01	0.03		17.92	0.02	88	12.99	0.01	88	8.30							0.92	127.1	0.16	20.7
	22.01	0.03		17.92	0.02	89	12.99	0.01	89	8.26							0.92	127.1	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.01	90	8.26							0.92	127.1	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.01	91	8.30							0.92	127.1	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.01	92	8.33	0.00	92	2.85				0.96	130.0	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.02	93	8.37	0.00	93	2.88				0.96	130.1	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.02	94	8.44	0.00	94	2.91				0.96	130.2	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.02	95	8.44	0.00	95	2.91				0.96	130.2	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.02	96	8.44	0.00	96	2.91				0.96	130.2	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.02	97	8.44	0.00	97	2.91				0.96	130.2	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.02	98	8.44	0.00	98	3.08				0.96	130.3	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.02	99	8.44	0.00	99	3.39				0.96	130.7	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.02	100	8.44	0.00	100	3.82				0.96	130.9	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.02	101	8.44	0.01	101	3.91				0.96	131.2	0.16	20.7
	22.01	0.03		17.92	0.02		12.99	0.02	102	8.44	0.01	102	4.26				0.96	131.5	0.16	20.7

22.01	0.03	17.92	0.02	12.99	0.02	103	8.44	0.01	103	4.45				0.96	131.7	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	104	4.49				0.96	131.8	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	105	4.64				0.96	131.9	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	106	4.70				0.96	132.0	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	107	4.74				0.96	132.0	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	108	4.66				0.96	131.9	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	109	4.82				0.96	132.1	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	110	4.88				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	111	4.88				0.96	132.1	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	112	4.86				0.96	132.1	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	113	4.86				0.96	132.1	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	114	4.84				0.96	132.1	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	115	4.84				0.96	132.1	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	116	4.88				0.96	132.1	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	117	4.88				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	118	4.91				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	119	4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	120	4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	121	4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	122	4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	123	4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	124	4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	125	4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	126	4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	127	4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01	128	4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95				0.96	132.2	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.00	134	1.58	0.97	133.8	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.00	135	1.58	0.97	133.8	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.00	136	1.57	0.97	133.8	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.00	137	1.57	0.97	133.8	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.00	138	1.57	0.97	133.8	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.00	139	1.57	0.97	133.8	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.00	140	1.65	0.97	133.9	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.00	141	1.81	0.97	134.0	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.00	142	1.93	0.98	134.1	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.00	143	2.08	0.98	134.3	0.15	20.7
22.01	0.03	17.92	0.02	12.99	0.02		8.44	0.01		4.95	0.01	144	2.26	0.98	134.5	0.15	20.7

APPENDIX 5: FLOW SPLIT CALCULATION

FLOW SPLIT ANALYSES FOR RESERVOIR NOS. 1, 2, AND 3.

Note 1). all of measurements for Length and Area are based on site plan drawing
2). travel time based on t50

INLET ANALYSES

Inlet1

Flow=	170.0	ML/d	
=	118.1	m^3/min.	

Inlet 2

L of pipe=	340	m	(from Inlet1 to Inlet2)
D of pipe=	2.1	m	
A of pipe=	3.5	m^2	
Time travel=	12.5	min.	(t50 Inlet2 - t50 Inlet1)
Velocity=	27.2	m/min.	
Flow=	94.2	m^3/min.	

Flow Split

Cell 1=	23.9	m^3/min.	20	%
Cell 2&3=	94.2	m^3/min.	80	%
Assume=	1). split Cell 2&3 =		38% & 42% (check the assumption later)	
	2). inlet profile 3=		inlet profile 2 with shift	

Inlet 3

L of pipe=	5.0	m	(from Inlet2 to Inlet3)
D of pipe=	2.1	m	
A of pipe=	3.5	m^2	
Flow=	49.6	m^3/min.	
Velocity=	14.3	m/min.	
Time travel=	0.3	min.	(shift of inlet 2 and inlet 3)

Time Analyses

T10 from Convergence:		=	137	min.		
Time Travel:						
Pipe System-Inlet1:	70	m	Total Volume=		2631	m^3
Pipe Inlet1-Otlet2:	340	m	Pipe Td=		22.3	min.
Pipe Outlet 2&3-Outlet1:	270	m				
Pipe Outlet 1-Convergence:	80	m				
Td:		=	903.3			
		Total=	926	min.		

OUTLET ANALYSES (CHECK THE ASSUMPTION)

Convergence

t50=	488	min.

Outlet 1

L of pipe=	80	m	(from Outlet1 to Convergence)
A of pipe=	3.5	m^2	
Flow=	23.6	m^3/min.	(assumed: Flow Inlet = Outlet)
Velocity=	6.8	m/min.	
Time travel=	11.7	min.	
Checking Time=	488.0	min.	
Correction Time=	476.3	min. ——	C/Co= 0.61

Outlet 2

L of pipe=	340	m	(from Outlet 2 to Convergence)
A of pipe=	2.1	m^2	
Flow=	44.9	m^3/min.	
Velocity=	21.4	m/min.	
Time travel=	15.9	min.	
Checking Time=	488.0	min.	
Correction Time=	472.1	min. ——	C/Co= 0.57

Outlet 3

L of pipe=	350	m	(from Outlet 3 to Convergence)
A of pipe=	2.1	m^2	
Flow=	49.3	m^3/min.	
Velocity=	23.5	m/min.	
Time travel=	14.9	min.	
Checking Time=	488	min.	
Correction Time=	473.1	min. ——	C/Co= 0.52 or 0.48

Total C/Co= %Flow(1)xC/Co(1) + %Flow(2) x C/Co(2) + %Flow(3) x C/Co(3)
= 0.56 ——— error = 11 %
(out of 0.50) (assumption accepted !)

Note: assuming an error data at t=355 min., taking interpolation for data between t=335 min.(C/Co=0.44) and 594 min.(C/Co=0.53)at t=47 gives: C/Co = 0.48

Total C/Co= 0.54 ——— error = 7 %
(out of 0.50)

APPENDIX 6: INSTRUMENT STANDARD DEVIATION

STANDARD Na SOLUTION TEST

Reading No.	0 mg/L Na	5 mg/ L Na	10 mg/ L Na	15 mg/ L Na	20 mg/ L Na
1	0.0	32.5	58.5	81.5	98.5
2	0.0	32.5	58.5	80.5	99.0
3	0.0	33.0	58.5	81.0	99.0
4	0.0	33.0	58.0	81.0	98.5
5	0.0	32.5	58.5	80.5	99.5
6	0.0	33.0	58.0	80.5	99.5
7	0.0	32.5	59.0	81.5	99.0
8	0.0	33.0	58.5	81.0	99.5
9	0.0	33.0	58.5	81.0	98.5
10	0.0	33.5	58.5	81.0	99.0
11	0.0	33.0	58.5	80.5	98.5
12	0.0	33.0	59.0	80.0	99.0
13	0.0	33.0	58.5	81.0	98.5
14	0.0	33.5	59.0	81.0	99.5
15	0.0	33.5	58.5	81.0	99.0
16	0.0	33.5	58.5	81.5	98.5
17	0.0	33.0	58.5	80.5	99.5
18	0.0	33.0	59.0	81.0	99.5
19	0.0	32.5	59.0	81.5	99.5
20	0.0	33.5	59.5	81.0	99.0
21	0.0	33.5	59.0	81.5	99.5
22	0.0	33.0	59.0	81.5	99.0
23	0.0	33.5	59.0	81.5	100.0
24	0.0	33.0	58.5	82.0	99.0
25	0.0	33.0	59.0	81.0	98.5
26	0.0	32.5	58.5	81.0	98.5
27	0.0	33.0	58.5	80.5	98.5
28	0.0	33.0	59.0	81.0	99.0
29	0.0	33.5	59.0	81.0	99.0
30	0.0	33.5	59.5	81.0	99.5
Average	**0.0**	**33.1**	**58.7**	**81.0**	**99.0**
Stand. Dev	**0.00**	**0.36**	**0.36**	**0.43**	**0.43**